upplement to Nature, June 16, 1898

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Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

Supplement to Nature,
June 16, 1898

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME LVII

NOVEMBER 1897 to APRIL 1898

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*To the solid ground
Of Nature trusts the mind which builds for aye.*"—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, NOVEMBER 4, 1897.

MIMICRY IN BUTTERFLIES AND MOTHS.

Researches on Mimicry on the Basis of a Natural Classification of the Papilionidæ. Part ii. *Researches on Mimicry.* By the late Dr. Erich Haase, Director of the Royal Siamese Museum in Bangkok. Translated by C. M. Child, Ph.D. Pp. 154 and 8 coloured plates. (Stuttgart: Ernin Nägele. London: Baillière, Tindall, and Cox, 1896.)

IT is, in some respects, a matter for regret that this important and painstaking work has appeared. The treatment falls far short of the pretensions of the author, and is marred by numerous grave imperfections; and yet the plan is so comprehensive, and the amount of valuable detail so great, that the appearance of a better work will probably be long delayed. The detail which forms the real merit of the work is piled together in a most inartistic manner, so that every reader, except the serious and determined student of the subject, cannot fail to be repelled, and even to the latter the task will be most tedious. And yet there is no subject which is capable of being made more interesting and attractive—alike to the beginner and the advanced student—than mimicry.

The volume deals with mimicry wherever it is found in organic life, beginning with a brief mention of it among flowering plants, and then giving a short account of its occurrence in Arachnida, Orthoptera, Hemiptera, Hymenoptera, Neuroptera, and Coleoptera. It is then treated at great length and detail in the Lepidoptera, the subject being divided on a geographical basis into the models and mimetic forms of (1) the Indo-Australian, (2) the African, (3) the Nearctic, and (4) the Neotropical regions. The mimicry of Coleoptera and Hymenoptera by Lepidoptera is next briefly considered; then follows a short account of mimicry in Diptera, Mollusca, Batrachia, and Reptilia (of the four above-named regions), Birds and Mammals. The memoir concludes with an important general section, dealing in various sub-sections with the history and origin of mimicry in Lepidoptera, and the objections which have been raised against it, and with the biological significance of mimicry in the animal kingdom and its relation to other forms of protective adaptation to the environment.

The vast display of facts and details upon all points prepares a reader to believe that the speculative part of the work will be marked by extreme caution, and guarded by the most scrupulous regard for all available evidence. When, however, the author does begin to speculate, he shakes off all restraint, and indeed in most cases all prudence, and makes the rashest suggestions as calmly as if they were well supported. Good examples of this are to be found in most of his confident statements as regards the past history of the warning and mimetic groups in the Neotropical region (pp. 116–119); in the calm assertion that the variations which have been developed into mimicry were due to "an unfavourable condition of the species, which would cause variations among the females"; in the conclusion, for which the most inadequate evidence is offered, that "the development of the *Neotropinæ* has reached and passed its maximum" (p. 118). We do not often meet with this combination of rash speculation with an almost tedious collection and heaping together of facts, in English works, perhaps because we are less patient in the latter, rather than more cautious in the former.

One very irritating feature of the work is the positive statement of conclusions without any recognition or discussion of the obvious difficulties which they encounter. Thus Haase's contention that what he calls the *Melinæa* type of colouring—

> "may be regarded as a characteristic expression of the special, purely physical and chemical influences of the Neotropic climate on a type of colouring originally black and white"—

is opposed by the want of evidence that effects so produced are hereditary—a difficulty which, at least, merits consideration. Very similar, and even more annoying, are the confident statements which are upset by other statements in a different part of the work. Thus, on p. 138 we are told in spaced type that "in all species which are mimetic in both sexes the female resembles the model more closely than does the male"; while in other

parts the author admits the existence of large groups in which both sexes are equally mimetic. Again, his frequently-stated dictum, that mimicry begins with the female, is controverted by the subsequent admission that he is unable to offer any sufficient proofs of it in some of the most important groups.

The author has the most extraordinarily exaggerated notions of the importance of his own contributions to the subject, and he frequently speaks as if he were one of its pioneers, and, with cool assurance, ranges himself beside Bates and Wallace, or more frequently himself claims the credit for work which they had long before accomplished. Thus, on p. 93 he speaks of

"the fact which I have so firmly established, viz. *that all mimetic modifications appear first in the female, this sex being so much more important than the male for the preservation of the species.*"

In the first place, this principle is by no means firmly established as of universal occurrence; in the second, all that is really true in the statement was brought forward long ago by Wallace. Again, on p. 100 he states with all the insistence of spaced type:

"Through my observations in Siam I have arrived at the general conclusion that those larvæ which conceal themselves most carefully or show the most perfect protective adaptation are probably those most sought by their enemies on account of their especial edible qualities."

By this unjustifiable or, accepting the most favourable interpretation, ignorant claim to a principle enunciated many years ago by Wallace, Haase puts in a most unfavourable light the really useful work which he has done in the comparatively humble position of a supporter of a well-established and thoroughly accepted conclusion.

Again, on p. 123 he calmly appropriates a principle which we owe to Bates:

"Thus, we find in these cases also a confirmation of our principle that it is always the rarer immune species which mimics the more common form in order to escape pursuit in its swarms."

The examples quoted above sink, however, into insignificance beside the passage which opens the section "Objections to the Theory of Mimicry" on p. 123: "The attacks on the hypothesis held by Bates, Wallace and myself, viz. that mimicry is the result of natural selection, &c." Having gone so far, Haase was no doubt astonished at his own self-effacement in thus placing his name after the distinguished naturalists to whom we are really indebted for something more than a patient accumulation of facts. Others will, however, feel that it is a piece of sheer impudence for Haase thus to range his name beside the pioneers of the subject to the exclusion of their true compeers Fritz Müller and Roland Trimen.

For a keen naturalist possessing a wide acquaintance with insect form and insect life, Haase shows a strange want of grasp of the well-known principles which operate among living beings in the natural state. Thus he continually speaks as if the protective qualities which accompany a warning appearance confer absolute immunity—an immunity as complete for the larva against the attacks of parasites as for the imago against insect-eating enemies. The term "immunity" ought not to be used at all with regard to these forms, unless very carefully qualified. Such a heading as that on p. 96, "Origin of Mimicry between Non-immune and Immune Lepidoptera," is liable to convey a very false impression of the facts of nature. We may feel confident that the average ratio of extinction to survival is the same in both groups—that a pair of the so-called immune species, in spite of all their numerous progeny, are upon the average succeeded by a pair only. The warning colours and the qualities they imply do indeed secure a high degree of immunity from the attacks of certain enemies, especially during certain stages, but other enemies have acquired the hardihood necessary to make use of the abundant and easily captured prey. So far from accepting Haase's dictum (p. 97) that

'it is certain that the early stages of immune butterflies suffer in general less from parasites than those of other Lepidoptera,"

we may feel confident that the reverse is the truth. Haase brings before us an unworkable theory according to which the species with warning colours must continue to increase in numbers, indefinitely from generation to generation. No doubt at the very origin of this special means of defence the species concerned were enabled to increase largely in numbers, and very many of them have reached a condition of equilibrium as abundant and dominant species. But as soon as this equilibrium is reached there is no interference in the general law that the amount of extinction keeps down the numbers of the species to a certain average; and we may therefore feel sure that the relative immunity from the attacks of certain enemies, and during certain stages, is compensated by the excessive attacks of other enemies, and during other stages; and furthermore, that during the progressive growth of the numbers of the species, each increase was attended by increased attacks until equilibrium was reached. Haase depicts a state of affairs which would cause an indefinite increase, and could lead to nothing but the extinction of the food-plant, and consequently the disappearance of the species. The keen observation of Belt detected some of the ways in which the numbers of unpalatable butterflies are kept down; for he noticed a flower-haunting spider which eagerly devoured them, and a wasp which stored them up in its nest. In order to support his views of extreme immunity, Haase makes, as regards these observations of Belt, the absurd suggestion that "it is perhaps possible that the mimic was mistaken for the model."

Haase shows a similar want of insight in his contention that mimicry and protective resemblance arose in a time of great struggle which has now ceased to exist. He concludes his work in these words:

"It is probable that all these resemblances to the moving or motionless and the living or lifeless environment have arisen in the interest of the preservation of the species from extinction during periods when the struggle for existence was most bitter, and from chance variations which corresponded to this purpose and whose further development was aided by natural selection and fixed by inheritance. Under these circumstances it appears then, to close with the apt words of Brauer, that 'the struggle for existence being ended, the forms reach a state of equilibrium, and the living species (being under the same conditions) are preserved from extinction.'"

All this is the most utter folly; the struggle for existence is now what it has ever been, fluctuating in degree, but always severe, and we know that when a species is shielded from the struggle as regards any part of its organisation, that part is very far from maintaining an equilibrium unchanged.

The suggestion that the unpalatable qualities are due to the juices of the food-plant of the larva has often been made before, but never with so much insistence as in Haase's work. He quotes a number of cases in support of his contention, and neglects those which oppose it. Haase would apparently deny to insect physiology the power to construct a protective odour or flavour, although the laboratory of an insect's body has been shown to be a marvellous workshop producing all kinds of unexpected compounds, and although the food-plants of many of the commoner of our distasteful European moths do not belong to any poisonous or acrid category. Although it is possible that the noxious or nauseous qualities may, in certain instances, be borrowed ready-made from plants, such an origin is as yet unproved ; while its universality, as assumed by Haase, has been effectually disproved.

For a work of such great pretensions the want of a wide and adequate acquaintance with other writers is somewhat remarkable. Thus Dixey's memoir on the Phylogeny of the wing-markings of Vanessidæ and Argynnidæ, as well as that on the Pierinæ should have been consulted ; for the author often attempts to reason upon the same lines, without having devoted any special study to the subject. In speaking of the different forms of the female of *Papilio merope* (*cenea*) he states (pp. 45, 46) that Mansell Weale *captured* a large number. In reality, the evidence supplied in support of Trimen's argument that these different forms were the females of a single species with a very different male, was of a far more satisfactory kind ; for Mansell Weale *bred* all the forms as well as the male from larvæ taken upon a single tree. Furthermore, no account of this most remarkable case can be regarded as adequate without a detailed reference to Trimen's classical paper. The reference is here and on p. 104 of the most meagre and unsatisfactory kind. Again, there is no allusion to Westwood in the account of the early history of the subject, or to Gahan in the account of mimicry in Coleoptera (p. 131). In his consideration of the classification of mimicry, warning colours, &c., suggested by the present writer, the author is satisfied with the study of a second-hand account of an easily accessible work.

Again, on p. 123, Haase states that Wallace, as well as Fritz Müller, originated the explanation of resemblance between inedible species and genera. As a matter of fact, we owe to Fritz Müller alone the important suggestion that forms which resemble each other and thus combine their advertisements, so to speak, are recognised with a smaller expenditure of lives than those which possess independent advertisements, each of which requires to be learnt separately. The fact of such resemblance was first recognised by Bates, but its explanation remained a difficulty under the theory of mimicry which we received from him. Wallace freely acknowledged the debt which we owe to Fritz Müller, and at once saw the great and far-reaching importance of the new suggestion. One great fault of the present work is the failure to recognise this importance, and the attempt to explain nearly all cases on the lines of Bates' theory of specially protected model and defenceless mimic, instead of constantly introducing the useful conception of resemblance for mutual advantage between specially protected species and groups.

Thus, to take but a single example, the treatment of the resemblances of the Erycinidæ (pp. 61, 62), as well as that of some of the Pierine genera, would have received much light from the Müllerian standpoint.

On p. 134 the distinction between protective and aggressive mimicry is ascribed to the present writer, although it was made by many writers long before he contributed anything to the subject. Having made this error, Haase goes on to criticise the cases included under the latter term, stating that "the disguise itself always serves only as a means of protection, and never as a weapon of attack, even when borne by the aggressors." He then proceeds to destroy his own criticism by citing several cases (p. 135) in which he maintains that the resemblance does act as a weapon of attack. It is to be hoped that the translator is to some extent responsible for this tissue of mistake and self-contradiction. At the moment of writing, access to the German original is impossible.

There are a number of errors in the systematic part of the work which we should hardly expect to see. Thus the name *Hypolimnas bolina* (L.) is given when *H. misippus* (L.) is intended (p. 41), and the appearance of the type form is wrongly ascribed to the var. *inaria* (Cr.), although this may be a mistake of the translator. In Plate xi. (Fig. 76) an *Anthomyza* is described as a *Hyelosia*, and in the same plate an undoubted representation of *Methona confusa* (Butl.) in Fig. 78, is stated to be *Thyridia psidii* of Linnæus, the author being careful to add the words "not *Methona*" after the generic name. There has been much confusion between these two closely convergent, although in reality widely different species—so much so indeed that even Bates was deceived —but the account given by Godman and Salvin in the "Biologia" places the matter on a secure basis, and clearly shows that the Linnean species is *Thyridia psidii*, possessing white spots on the black border of the hind wing. The latter species is also distinguished by a small reddish spot at the base of the fore wing ; and both these characteristics being absent from Fig. 78, we can only conclude that it represents the species of *Methona* from which they are also absent. A very unaccountable error is the positive statement (p. 145, *note*) that there are no "unmistakably mimetic species" among the Lepidoptera of Madagascar. The author must surely have been aware of the occurrence of *Hypolimnas misippus* (L.) in that island. In the same note the impression is conveyed that there is a widespread belief that isolation, as in islands, rather than the keener competition of continental areas, favours mimetic modification ; and Haase apparently takes some credit to himself in supporting the opposite view. But the ancestral character of island faunas in relation to mimicry was recognised long before the appearance of Haase's work, and has never been seriously disputed.

Another obvious error occurs on pp. 147, 148, where the resemblance of the *imagos* and not the *larvæ*, as

stated, of *Calocampa exoleta*, &c., to sticks, is intended. One is at a loss to understand why some ancestral time at which Haase imagined that food was especially scarce, and the enemies of insects especially keen, should be spoken of as a "Palæolithic Period" (p. 118).

At the end of the volume the author contributes a section, entitled "Mimicry a form of protective adaptation to the environment" (pp. 145-151). In these pages he treats, in a very inadequate manner, of protective resemblances in general. The important and widespread cases of variable colour resemblances he does not even mention. The attempt is made to distinguish between protective resemblance and mimicry on the ground that the latter is an imitation of moving objects, the former of motionless ones. This distinction, which has been drawn before, seems to the present writer to be unreal, and, so far as it holds, to be of little importance as a basis for classification. There are many examples of the protective resemblance of moving objects —butterflies and moths which resemble leaves whirled along by the wind; larvæ and cocoons which resemble sticks, &c., swinging by a thread. The essential distinction lies in the fact that in protective resemblance the model is of no interest to the enemies of the imitator, while in protective mimicry the model is dreaded or disliked by the enemies; the effect of protective resemblance is concealment; the effect of protective mimicry, conspicuousness.

In this section the wonderful resemblance of butterflies of the genus *Kallima* to dead leaves is briefly discussed, and the author concludes (p. 147) that

> "the extraordinarily manifold variations among *Kallima*, &c., show, not only that these so perfect resemblances of withered leaves, and often of those covered with rust-fungus or partially eaten by larvæ of *Agromyza*, are the highest development of mimicry of leaves, but they also indicate that these are the youngest forms, and are still under the influence of natural selection, which will gradually obliterate that which is less fitting."

It is, of course, very improbable that a species which has attained the highest development in any character could still remain in the formative stage as regards the very same character. As a matter of fact, the "extraordinarily manifold variations" of *Kallima* are not the ordinary individual differences upon which natural selection acts, but rather certain varied forms into which the species has been thrown by natural selection, causing it to resemble not one, but many of the appearances presented by dead leaves, and thus conducing towards its protection. This high product of selective action has been mistaken by Haase for the mere material for selection to begin its work upon.

There are some excellent pieces of work and interesting suggestive inferences to be found in the memoir—not to be compared to the great hypotheses connected with the names of Bates, Wallace, and Fritz Müller, but valuable additions to the subordinate parts and details of the subject.

Of this kind is the discussion on mimicry in the *Papilioninæ* (pp. 80-95), to which Haase has given special attention, and which forms the subject of Part i. of his work, as yet untranslated into English. In this section he produces evidence that the species of *Papilio* which are especially mimicked by others belong to the genus *Pharmacophagus*, and, as he thinks, derive their qualities from the poisonous or acrid larval food.

The contention (p. 97) that specially protected butterflies but rarely avail themselves of a distinct and markedly conspicuous "warning colour," that "among the *Neotropinæ* in general the wing-colouring, with its brilliant yellow, rusty-brown and black, is more beautiful than unpleasant," must be admitted to be true; the conclusion was, in fact, stated in 1890 by the present writer, who also pointed out that a conspicuous appearance is nevertheless attained because "the colours spread on the parts which are exposed during rest, and the flight becomes sluggish, so that they are displayed as completely as possible" ("Colours of Animals," Lond., 1890, p. 191).

On p. 106 we meet with an interesting case (that of four white spots on the outer margin of the hind wing of the female var. *protogenia* of *Elymnias undularis*, Dru.), in which it is argued with force that changes caused by reversion to an older type of marking have been made use of to aid a mimetic resemblance. In a note on the same page, Haase brings forward *Cethosia cyane*, Dru., as a unique example of a closer resemblance on the part of the male than the female to another specially defended insect—*Danais chrysippus*. He makes the very probable suggestion that the *Cethosia* is also itself specially defended.

Interspersed with much almost worthless speculation there is a great deal that is suggestive and valuable in the analysis of the various patterns of those *Neotropinæ* which are resembled by other butterflies, including many belonging to different sections of the group itself (pp. 116, 117). The various tables embody an immense amount of careful comparison and the examination of a vast number of specimens; they will prove of the highest value to future workers. E. B. P.

(*To be continued.*)

A DEVONSHIRE GEOLOGIST.

A Memoir of William Pengelly, of Torquay, F.R.S., Geologist, with a Selection from his Correspondence. Edited by his daughter, Hester Pengelly. With a summary of his scientific work, by the Rev. Prof. Bonney, F.R.S. 8vo. Pp. xi + 341; with portrait and 10 illustrations. (London: John Murray, 1897.)

THE story of William Pengelly is one of the pursuit of knowledge under difficulties, and of the achievement by the hero of an honoured place amongst those who have rendered distinguished service to science. Many of his paternal ancestors were sailors, and his father was captain of a small coasting vessel, in which his son William accompanied him, after receiving an elementary education at East Looe in Cornwall. For four years the lad was engaged in a seafaring life, but in 1828, at the age of sixteen, and at the earnest desire of his mother, he returned to his native village, and was occupied for a few years in active manual labour. He had, however, developed a passion for learning, and every hour that could be spared, was devoted to the acquisition of knowledge, and more especially of mathematics. Having so far prepared himself, after severe

study and under great privations, for more congenial labours, he removed to Torquay and opened a small day-school. Here he met with good success, which rapidly increased as the years passed by.

His earliest geological lesson had been learned at Lyme Regis when, as a sailor boy, he had been weather-bound on the Dorset coast, and had observed a fine ammonite. Later on the reading of a chapter on geology in a work published by the brothers Chambers, gave him his first insight into the objects of the science, and led him to devote attention to the subject. Thus, when he went to London in 1843, he was interested in visiting the British Museum, the Royal College of Surgeons, and the Museum of Economic Geology (as it was then called) at Craig's Court. He had some difficulty in finding the last-named museum.

Torquay has always been a locality of great interest to the geologist, and when Pengelly commenced his labours it was not long after the founding of the Devonian system by Sedgwick and Murchison, aided by Lonsdale. Moreover, De la Beche and Godwin-Austen had published their important researches on South Devon, and McEnery had brought into notice the interest attaching to the local bone-caves. No wonder that Pengelly, when once his ardour had been kindled, started to explore the district with vigour and enthusiasm.

Many little adventures and anecdotes are recorded with reference to his geological expeditions. On one occasion at a wayside inn, where he had taken a seat on the kitchen settle, Pengelly answered some inquiries addressed to him by three labourers, and finally entertained them to such good effect on the subject of stone-breaking, that the landlord became keenly interested. Seeking an interview next morning with Pengelly, he thus expressed himself:

"I hope no offence, sir: but ef you'd stop 'ere for a foo days, or a week, and talk to the men in the evenin's, you shud be welcome to meat, drink, washing, and lodging free gratis. I'm sure lots o' men wud come an' hear 'ee, and I should zell an uncommon zight o' beer."

In 1855 Pengelly went, for the first time in London, to an evening meeting of the Geological Society. In a letter to his wife he says:

"There were probably about forty persons present, which I believe is considered a good attendance. We were rather late, and found on our arrival that a paper was being read descriptive of Mauna Loa, the volcano in Owhyhee. At its close, Austen, a well-known geologist, and who once lived at East Ogwell, read a paper on the 'Probability of coal existing at workable depths near London.' . . . A discussion followed the paper, in which the author was by no means spared, as the various speakers expressed themselves freely."

What seems remarkable to us is the small attendance at the reading of this important paper by Godwin-Austen, and the fact that it was given second place at the meeting! Next year Pengelly attended another meeting of the Geological Society, when papers were read by Carrick Moore and Babbage. He says, "It was a magnificent meeting, and made me wish for a town residence."

Pengelly first attended the British Association in 1856, at Cheltenham, and he was present at all subsequent meetings up to 1889, with the exception of that held at Montreal in 1884.

In 1858 his detailed researches on the caverns of Devonshire may be said to have commenced. In that year the Brixham Bone-cavern was discovered, and the investigation was undertaken by the Royal and Geological Societies; a committee being appointed by the latter body, and the exploration being placed under the superintendence of Mr. (afterwards Sir Joseph) Prestwich and Mr. Pengelly. The bulk of the work naturally fell to Pengelly. It was long before the results of this investigation were issued. The delay, indeed, was aggravating, for it was not until 1873 that the full account was published.

Meanwhile Pengelly became engaged in a systematic examination of the lignites and clays of Bovey Tracey, in conjunction with Dr. Oswald Heer, who undertook the determination of the plant-remains. This important work was executed at the expense of the Baroness Burdett-Coutts, and the results were published in 1862. The age of the deposit was regarded by Heer as Miocene, but it has since been shown by Mr. Starkie Gardner to be Eocene.

In 1864 the first steps were taken to secure a systematic exploration of Kent's Hole, Torquay; and, aided by grants from the British Association, the work was carried out by Pengelly, who for more than fifteen years devoted himself with never-flagging energy to the task. During these years he annually reported progress at the meetings of the British Association, and his discourses on these occasions formed an attractive feature in the proceedings of Section C. Here, as elsewhere in all his lectures, he contrived to blend his science with a considerable amount of humour, while his expositions were both clear and spirited.

With regard to the exploration of Kent's Hole, Prof. Bonney rightly observes that "it was the most complete and systematic investigation of a cavern which had ever been undertaken." The time and labour, the care and patience, exhibited by Pengelly, and the precision with which he noted every fact, were extraordinary, but thoroughly characteristic of the man. His very full reports will ever remain as a monument of these labours. He had intended to publish a separate book on Kent's Cavern; but, considering that all particulars have been given in his many papers, the abandonment of this task need not seriously be regretted.

This outline of his principal work affords but a meagre idea of the activity of the man. He not only spent a good deal of time in lecturing in many provincial towns, but devoted much energy to local institutions in Torquay. The organic remains from various formations in Devonshire were eagerly sought for, and a fine collection of Devonian fossils which he had gathered together was presented to the Oxford Museum by the Baroness Burdett-Coutts in 1860.

His main efforts were always directed to the geological questions relating to Devon and Cornwall. He was master of all the literature, and many of his contributions were most useful summaries of knowledge on particular subjects. Curiously enough, but little is said in this volume of his fellow-workers in Devonshire. Dr. Harvey B. Holl, who, after Godwin-Austen, published a detailed account of the geology of South Devon, is not mentioned. Nor is much said of G. W. Ormerod nor of A. Cham-

pernowne, the latter of whom had laboured more assiduously than any previous worker at the intimate structure of parts of South Devon. More frequent references are made to William Vicary, who happily survives, and whose grand collection has done so much to illustrate the life-history of the rocks of Devonshire; and there are several references to John Edward Lee, though not to his collection of Devonian fossils, perhaps the finest of its kind as regards South Devon. Such omissions may not be deemed of great importance, but to one not familiar with the subject the book is apt to convey the notion that Pengelly was almost the sole worker, in his time, on Devonshire geology.

A great portion of the volume is taken up with letters from Pengelly to various members of his family, giving interesting accounts of his journeys and lectures, and of the many men of science and others whom he met; and there are numerous extracts from letters of Lyell and others addressed to Pengelly. The fame of Kent's Cavern brought many an illustrious visitor to Torquay, and although Pengelly's time was a good deal taken up in describing the cavern and its contents, he was naturally gratified at the interest manifested. In society he was always a genial companion, full of fun, and notoriously full of puns; so much so indeed that in 1862, at the first meeting of the Devonshire Association, which he was mainly instrumental in founding, he was christened Mr. *Pun*gelly by the President, Sir John Bowring.

Prof. Bonney, in a concluding chapter, has given a capital account of the scientific work of Pengelly; and appended to it is a list of his papers, apparently compiled from the Royal Society "Catalogue of Scientific Papers." Unfortunately these are not enumerated in strict chronological order, nor is the list complete. It would have been well to make it so, for it would have been an appropriate record of Pengelly's many-sided labours. One of his elaborate papers, published in the *Transactions* of the Devonshire Association (vol. v.), dealt with "The signs of the hotels, taverns, inns, wine and spirit vaults, and beershops in Devonshire"—a subject that should not be without interest to the field-geologist.

Those who were personally acquainted with Mr. Pengelly will read this work with especial interest, including the accounts of many minor circumstances that otherwise may appear somewhat trivial and unnecessary. When, however, we remember that the work has been edited by the loving hand of a daughter, we may well pardon any excess of zeal, and thank her for having given so excellent a biography of one who laboured manfully, enthusiastically, and successfully in the cause of science.

H. B. W.

MEXICAN ARCHÆOLOGY.

Archeological Studies among the Ancient Cities of Mexico. Part ii. By W. H. Holmes. Pp. 200. (Chicago, 1897.)

THE second part of Mr. Holmes' work on the ancient cities of Mexico has this year appeared, and completes the first part of a series of anthropological publications to be produced under the auspices of the Field Columbian Museum at Chicago. This work, extending as it does to over 300 pp. and containing numerous plans, sketch-maps, drawings and photographic reproductions, has been conceived on a somewhat more ambitious scale than previous publications of the Field Columbian Museum. It is evident at a glance that the greatest pains have been taken in the preparation of the plans and drawings, while the numerous papers Mr. Holmes has already contributed to various scientific journals are a sufficient guarantee of his competence to undertake a survey of one or more of the cities of ancient Mexico. In this field of archæological research there are already many patient workers who devote much time to the excavation and survey of the ruins, but there is no lack of material for study, and many sites still remain comparatively untouched. We must admit, however, that the two parts before us are a little disappointing. From the obvious care expended on them we were prepared to welcome them as a contribution of the first importance to Mexican archæology, but on perusal they do not quite justify our expectations. Let us hasten to add that this is due to no fault of the author, but is a necessary consequence of the plan and nature of the expedition of which the volumes are a record.

Mr. Holmes' studies among these ancient sites were undertaken in the spring of 1895, when he spent three months travelling in these regions with Mr. A. V. Armour, of Chicago, and other friends. Botany, geology, anthropology and natural history were impartially studied by the party, and, as Mr. Holmes remarks in his preface, he himself as "Curator of Anthropology" in the Field Columbian Museum, "was expected to examine and describe such archeologic remains as happened to be encountered during the journey." It must not, however, be supposed that the book is merely the record of a pleasure trip. The localities visited are dealt with systematically, but in every case too little time was given to the examination and measurement of the ruins. The first part of the trip was devoted to the monuments of Yucatan, when the islands of Contoy, Mugeres, Cancun and Cozumel, and the mainland opposite them, were examined in less than two weeks, during which period the party went as far south as Tuloom, where they did not land, but Mr. Holmes sketched the ruins from the sea. In the interior of Yucatan the remains at Tikul, Uxmal, Izamal and Chichen-Itza were also examined in less than a fortnight. The first part of the book dealt with these places, but it will be obvious that so little time having been spent at the actual ruins, Mr. Holmes' notes were necessarily superficial. He thereby lays himself open to correction by more systematic explorers than himself, and, as a matter of fact, Mr. Alfred P. Maudslay, who in 1889 encamped for five months at Chichen-Itza, which Mr. Holmes and his party in 1895 did in a week, has already pointed out in the columns of NATURE (vol. liv. pp. 274*ff.*) several inaccuracies in his observations. The second part of the work, which has just appeared, deals with the monuments of Chiapas, Oaxaca, and the Valley of Mexico, and though larger in bulk than its predecessor, represents the result of observations made in an even shorter period, four days being spent on the ruins of Palenque, a week at Mitla, a day on Monte Alban, while from Mexico two brief excursions were made to San

Juan Teotihuacan. It is needless to point out that this publication could not have been compiled had the places never been surveyed and described by other explorers. Mr. Holmes frankly admits that his work is no more than a sketch of the sites he visited "seen at a passing glance"; but even regarded merely as an introduction to the study of Mexican archæology, its value to the student would have been much increased by the inclusion of references to the extensive literature on the subject, and by a discussion of the work accomplished by previous explorers and archæologists.

OUR BOOK SHELF.

Manuale del Chimico e dell' Industriale. By Prof. Dr. Luigi Gabba. Pp. xvi + 442. (Milan: Ulrico Hoepli, 1898.)

La Fabbricazione dell' Acido Solforico, dell' Acido Nitrico, del Solfato Sodico, dell' Acido Muriatico. By Dr. V. Vender. Pp. v + 312. (Milan: Ulrico Hoepli, 1898.)

Leghe Metalliche ed Amalgame. By I. Ghersi. Pp. xii + 431. (Milan: Ulrico Hoepli, 1898.)

THE three volumes, the titles of which are given above, belong to an extensive series of manuals published by the firm of Hoepli, Milan. More than five hundred of these Manuali Hoepli have now been published, covering a variety of subjects in science, letters, arts, and industries.

Prof. Gabba's volume is a collection of tables of physical and chemical data, and of analytical processes, for the use of analytical and technical chemists, directors of chemical works, students of chemistry, and others. The tables and the descriptions of methods of detecting various substances, and of carrying out a complete analysis or assay, will be found very serviceable to all technical chemists. The volume contains a mass of physical and chemical data, and it will prove as useful to analysts as engineering pocket-books are to engineers.

Dr. V. Vender's work on the manufacture of sulphuric acid, nitric acid, and hydrochloric acid, presents in a concise form the essential facts of these great chemical industries. In the case of each product, the substances employed in its manufacture, the general principle of the manufacture, the theory of the various processes, the details of construction of the plants in use, and methods of analysing the products, are described. The book is instructively illustrated; and though the text is in Italian, English chemists will find that they can read it by occasional reference to a dictionary.

In the third of Hoepli's Manuals referred to at the head of this notice, Signore Ghersi provides metallurgists with a handy book on metallic alloys and amalgams. The volume opens with a description of alloys in general, and then deals in succession with binary alloys, alloys of aluminium with common metals, nickel alloys, amalgams, alloys of gold, silver, and platinum, alloys for coinage and medals, bronzes, brass, ternary and quaternary alloys, Delta metal, fusible alloys, alloys which simulate various metals, and solders. There is an appendix containing useful tables of physical and chemical data referring to alloys, a long list of works cited, and a good index. The author frequently refers to recent investigations of metallurgists in various parts of the world, and his book does credit to him and to the scientific spirit in Italy.

Lectures on Quaternions. Part i. Introductory. By S. Kimura, Sendai, Japan.

WE are unable to read this treatise, because it is printed in Japanese. The mathematical formulæ and woodcuts show that the author is introducing his students to those elementary geometrical (curve and surface) illustrations of the vector calculus (mainly vector addition and differentials) which may be taken up without any knowledge of a quaternion. The characters are printed in horizontal rows instead of the usual vertical columns, and this might be taken as the text for a sermon on the modern changes in Japan. The concession is necessary if a student is to read mathematical formulæ with ease, yet it is one which need not alarm the scholars, and by making it the author takes away an objection to the use of Japanese characters, and so keeps his reader in touch with Japanese literature. Every Japanese reader of such a treatise is well acquainted with English, and if the teaching of mathematical science were to be considered by itself, all such books might just as well be printed in English. But it is well known to all who have studied the Japanese that they are not merely studying our commercial and military and scientific ideas, but how they may assimilate these ideas without undue hurt to their own old civilisation and developed instincts and fine moral character, which seem to them, and indeed to some of us, of a very much higher order than what we find in Europe. Well, the vector calculus can do little harm to anybody; but when Part ii. is published, and the author introduces his quarternions, he may be glad that the old scholars who protect the morals of his country are unable to understand what he is writing about. J. P.

Lehrbuch der Erdkunde für höhere Schulen. By Dr. Willi Ule. I. Theil (Für die unteren Classen). Pp. viii + 176. (Leipzig: G. Freitag, 1897.)

THIS is an excellent reading-book for children, but as it is printed in the German language, it will not be found very useful this side of the Channel. Written in a very simple manner, and dealing only with fundamental ideas, the author describes clearly and concisely the main physical features of the earth—such as mountains, plains, continents, races, &c. Each of the different countries is generally described, and typical illustrations are inserted here and there. Several paragraphs are also devoted to brief general descriptions of the weather, climates, elementary astronomical phenomena, map-drawing, &c. The author has succeeded in bringing together in a methodical and natural sequence a great amount of information which the children will read with delight. Names and numbers have been suppressed as far as possible in the text, these being added in tabular form at the end of each section, more for the use of the teachers than for the readers.

The Great Meteoric Shower of November. By W. F. Denning, F.R.A.S. Pp. 52. (London: Taylor and Francis, 1897.)

UPON the subject of meteor-observation, Mr. Denning teaches "as one having authority, and not as the scribes." This pamphlet, reprinted from the *Observatory*, furnishes meteoric observers with a number of interesting facts as to past November showers of Leonids, and prospects of observations between now and 1905. Mr. Denning deals in succession with the position of the Leonid radiant, the character of the radiant, the visible aspect of the individual Leonids, the real paths of the meteors in our atmosphere, minor meteor showers visible at the Leonid epoch, expected phenomena at the ensuing return, the observations required, and the November shower from Biela's comet. Every astronomical observer should possess a copy of the pamphlet, for the perusal of it will show him exactly what points require attention, and will thus increase the value of his observations.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Bee's Movements in a Room.

THE following was communicated to me by a friend of mine, Mr. E. W. Winstanley, of Trinity College, Cambridge, and, as it may have some value respecting the relations of insects to flowers, I think it worth putting on record. The observations were written down on the day after the occurrence, when he related to me the facts, and I reproduce them here in his own words:—

"Sitting reading in my room (15 Jesus Lane) by the open window, about noon, October 21—a sunny day—I became conscious of a buzzing sound, and, on looking up, found it due to the entrance of a bee. Noticing that certain objects seemed to arrest the insect's attention, I paid special heed to its movements. It first went across to the pictures on the opposite wall, following them round the room, and hovering a short time close to each of the coloured ones, then passing out of the door, which was wide open; returning, after a few seconds, it flew straight to the gas-shades, which, two in number, are situated one on each side of the mantelpiece; it lingered over the top of one, and then passed on to the other, and repeated this movement. It now took a second tour of the pictures, and after stopping a moment or two near one of the brass knobs of the curtain-pole, came again to the gas-shades and made a closer investigation of them, both by hovering over the top and by entering at the bottom around the gas-burners. It then visited in succession four ornaments on the mantel-mirror, drew near once more to the large central coloured picture, made a second exit by the door, coming back almost immediately, and, after dwelling near the two small coloured pictures for the third time, flew straight out of the window.

"It never actually alighted anywhere, remaining near the objects by the rapid quiver of its wings. The whole visit the bee paid me occupied probably five minutes or less. Although I did not examine it closely, I considered it to be a hive and not a humble bee."

The special features to notice in the above are the systematic way the bee flew about, and the nature of the objects which attracted its attention.

Any one on surveying the room would admit, I think, that the gas-shades and the pictures are the most brightly coloured things in it.

The gas-shades are semi-opaque, lily-shaped, and tinted from yellow to bright pink upwards; in fact, they resemble very large gamopetalous flowers (corollas).

The pictures in the room numbered seven, consisting of a large frame enclosing five photochrome views, of two small photochromes, and four photogravures. My friend says it was distinctly the coloured ones that attracted the bee, giving the other ones a mere glance, as it were. The photochromes are vividly coloured, blue predominating.

The remaining objects visited, the ornaments, are not striking or large, but have flowers painted on them on a white ground, mostly resembling blue forget-me-nots. My friend was somewhat astonished at the bee regarding these, as he was not aware, till he looked, that the vases were decorated thus. He is not a botanical student, and has no bias towards any theory of the flower; it was the methodical way the bee went about the room that arrested his attention. It is mainly owing to this fact that I thought it worth while to make his observations known. Recently some observers have put forward reasons for considering that the colour of the flower exerts little attraction towards insects, and that it is chiefly the odour. The above piece of information favours decidedly colour attraction. There was no perception of odour, or any flowers or plants present in the room at the time.

To my mind it seems rational to assume that colour and odour may play somewhat equal attractions, the scent serving to bring bees from a distance, and the colour helping to guide them directly to the honey. A bee becoming accustomed to associate nectar with conspicuously coloured objects, might thus learn to visit flowers wholly from colour-sensation, and, not having sufficient discriminating power, visit other brightly-coloured things as well.

J. PARKIN.

Trinity College, Cambridge, October 23.

A Test for Divisibility.

MAY I venture to supply a long-felt want amongst arithmeticians, viz. a general test of divisibility?

Let N be any integral number, and δ any divisor, then

$$\begin{aligned} N &= a + 10b + 10^2c + \&c. \\ &= a + b(\delta q + r) + c(\delta q + r)^2 + \&c. \\ &= \delta Q + a + br + cr^2 + \&c. \\ &= \delta Q + a + b(\delta q_1 + r_1) + c(\delta q_2 + r_2) + \&c. \\ &= \delta Q + \delta Q_1 + N_1 \\ &= \delta(Q + Q_1) + N_1. \end{aligned}$$

Here N_1 is the least general substitute for N, and is of the form

$$a + br_1 + cr_2 + dr_3 + \&c.$$

where the number of values of r_1, r_2 &c. cannot exceed $\delta - 1$. but may be much fewer, and constitute a recurring series found from

$$\frac{10^n}{\delta}, \text{ where } n = 1, 2, 3, 4 \text{ \&c.}$$

$$\begin{aligned} \text{Let } \delta &= 2, 5, \text{ then } N_1 = a \\ &= 4, \qquad = a + 2b \\ &= 8, \qquad = a + 2b + 4c \\ &= 16, \qquad = a + 10b + 4c + 8d \\ &= 3, 9, \qquad = a + b + c + \&c. \\ &= 7, \qquad = a + 3b + 2c + 6d + 4e + 5f + g + 3h + 2i + 6j + 4k + \&c. \\ &= 37, \qquad = a + 10b + 26c + d + 10e + 26f + \&c. \\ &= 11, \qquad = a + 10b + c \div 10d + \&c. \end{aligned}$$

and so on.

The practical importance of this general test must primarily depend on the brevity of the recurring period of r_n, but in special cases this objection may be removed.

Thus when $\delta = 11$, if $N_1 \div \delta = 11q$ we have

$$\begin{aligned} N_1 &= (a + c + \&c.) + 10(b + d + \&c.) \\ &= S \times 10S_1 = 11q. \end{aligned}$$

But $S - q = 10(q - S_1)$

where $(S - q) \div 10 = q - S = q_1$ suppose;

also $S_1 = (11q - S) \div 10$;

$$\therefore\ S - S_1 = 11\left(\frac{S - q}{10}\right) = 11q_1.$$

That is, the difference of the sums of the alternate series of digits is divisible by 11 if N or N_1 be so divisible. This result may be applied thus: Let a_3, b_3, c_3 &c. denote triple periods, and $\delta = 1001$, then

$$\begin{aligned} N_1 &= a_3 + 10^3b_3 + c_3 + 10^3d_3 + \&c. \\ &= (a_3 + c_3 + \&c.) + 10^3(b_3 + d_3 + \&c.) \\ &= S + 10^3S_1 \text{ which may be changed to} \\ &\quad S - S_1. \end{aligned}$$

Thus $S - S_1$ is a test for divisibility by 7, 11, 13, 77, 91, 143, 1001.

Again, if a_4, b_4, c_4 &c. denote quadruple periods and $\delta = 10{,}001$, then

$$N_1 = a_4 + 10^4b_4 + c_4 + \&c. = S - S_1$$

and is a test for $\delta = 73, 137, 10001$.

Again, if a_6, b_6, c_6 &c. denote sextuple periods and $\delta = 1{,}000{,}001$, then

$N_1 = a_6 + 10^6b_6 + c_6 + \&c. = S - S_1$ and is a test for $\delta = 101$; 9901.

As examples take

(1) N = 807,929,122; $\delta = 7, 11, 13, 143, 77, 91$;
$S - S_1 = 122 + 807 - 929 = 0$.
$\therefore$ the proposed number is divisible by δ.
(2) N = 67, 3558, 3491; $\delta = 73, 137$.
$S - S_1 = 3491 + 67 - 3558 = 0$.
(3) N = 360, 4536, 7388; $\delta = 73$.
$S - S_1 = 7748 - 4536 = 3212 = 73 \times 44$.
(4) N = 390, 9569; $\delta = 137$.
$S - S_1 = 9179 = 137 \times 67$.
(5) N = 585622, 677027; $\delta = 101$.
$S - S_1 = 91405 = 905 \times 101$.
(6) N = 954221, 304387; $\delta = 101$.
$S - S_1 = 649834 = 6434 \times 101$.

When the periods consist of similar groups, as

222, 222 ;
123, 123 ;
333, 777, 444 ;
333555, 333555 ;
5174, 1399, 1399, 5174 ;

divisibility by the formula $S - S_1$ may be determined by inspection, and this conclusion will not be modified by like permutations of each group. Thus 123123, 312312, 132132 &c. are each divisible by 7, 11, 13, 91, 143 &c.

Lastly, since r_n changes with every value of δ, no general formula for the determination of primes can exist.

HENRY T. BURGESS.

Tarporley, West Norwood, October 16.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.[1]

IT is difficult to know how best to review a volume consisting of such varied matter as the Report of the Proceedings of an Educational Congress. Even when restricted to technical education, the subjects that may be legitimately discussed are very numerous ; and with the constant widening of the definition, it is not easy to exclude any branch of knowledge, as outside the field of inquiry. After reading very carefully the closely-printed volume of nearly 300 pages, which includes the papers *in extenso*, and a summary of the discussions, we must own to some feeling of disappointment at the poverty of the results. Several of the writers and speakers are men of knowledge and experience, who write and speak with authority on their respective subjects ; but, nevertheless, the volume before us adds little to what was previously known, and we look in vain through its pages for any new light to guide us in solving problems that are still imperfectly understood. The papers are, of course, of unequal merit, and we propose briefly to call attention to a few only, selecting rather those the authors of which show themselves abreast of the difficulties to be overcome.

The Congress was the fourth of its kind, the two previous meetings having been held in Bordeaux, in the years 1886 and 1895, and the first in Brussels in 1880. The latest Congress, held in London, was organised by the Society of Arts—a society which has always shown a deep and very active interest in technical education. It occupied four days from June 15, when M. Leo Saignat and the Duke of Devonshire delivered short introductory addresses, till Friday, June 18, when it was brought to a close by a few words of thanks from the chairman, Sir Owen Tudor Burne, to those who had assisted.

It is not easy to correctly group the contributions under separate headings. Several papers were descriptive of the methods and conditions of education in the countries and districts with which the authors were familiar. Some few treated of educational problems, and these were perhaps of widest interest. The vexed question of the organisation of instruction and of examinations was very fully discussed ; a whole morning was devoted to papers bearing upon the teaching of domestic science ; and a special feature of the Congress was the prominence given to the subject of commercial education.

Among the papers dealing with educational method, those on the teaching of chemistry were certainly the most informing. The character of the chemical teaching best adapted to the requirements of persons actually engaged in industrial pursuits, and also to school children preparing for such pursuits, had recently been the subject of a thoughtful report, prepared by a Committee specially appointed by the Technical Education Board of the London County Council. This report had been widely circulated, and both Dr. Witt, of Berlin, and Dr. Lunge, of Zürich, referred to it in their communications to the Congress. It is doubtful, however, whether either of these professors fully appreciated the problem, as it presents itself to organisers of evening classes in this country. Neither in Germany nor in Switzerland is there anything approaching to the teaching of technological chemistry, by means of evening lectures, to artisans. When Dr. Witt states, in his paper on the "Relation existing between the teaching of pure chemistry and applied chemistry," that he "cannot admit any fundamental difference in the methods of research," every one will agree with him ; but when he says, "we want no schools for producing specialists," it may be reasonably thought that his generalisation is too far-reaching. There are successful dyeing schools in all parts of Europe, and he, himself, admits that "Dyeing, calico-printing, and paper-making are . . . industries which may rightly claim the necessity of some special instruction in the methods of manipulation," even if no other industries have like claims. Although Dr. Lunge, who is essentially a technologist, puts in a plea for the study of applied chemistry, his views do not differ essentially from those of Dr. Witt. He is at one with other chemical teachers in recognising the importance of training in the methods of research for all students. He says very truly : "Nothing in these times of ours is likely to turn out a first-class chemist, worthy of being later on put in charge of a large factory, who has not tried his hand at original research." Dr. Lunge insists, however, on the advantages of specialised training, and refers to the demand of Dr. Böttinger, head of a chemical factory, having under him a staff of more than one hundred chemists, for the establishment of more professorships of technological chemistry. It is, nevertheless, clear that the difference between the training in pure and applied chemistry which Dr. Lunge has in mind, consists mainly in the addition to the curriculum of technological students of a course of instruction in engineering, in order that they may advance beyond the position, to use his own words, of "testing slaves," to understand something of the processes of manufacture on a commercial scale. Dr. Lunge shares with most German chemists the opinion, that the knowledge of chemistry and technology that can be imparted to adults in night classes is useless from the manufacturer's point of view. He says : "I do not even think that apart from isolated exceptions, such knowledge is of much good to the foreman, whose duty it is to carry out instructions, and to see that the men do their work as prescribed by the staff." And, more definitely, he tells us, that "in Germany, even in those factories where the work is carried on with the greatest chemical refinement, the foreman and ordinary workmen are neither required nor even desired to know anything of chemistry." Dr. Lunge, in this statement, is, of course, referring to large chemical works in which there is a complete system of division of labour and sectional work, and where every difficulty, as it occurs, is at once submitted to some member of the large staff of chemists employed. But it is now generally admitted that there are many small trades in which a knowledge of chemistry is useful to the ordinary workman, and that the training, even when it proceeds from the process to the principle, may be made educationally valuable in supplementing the still imperfect, and too brief discipline of the elementary school. Prof. Armstrong's characteristic paper, indirectly bearing upon this subject, entitled "Heuristic instruction in physical science," was intended to show that the aim of sound science teaching should be to put learners in the attitude of discoverers ; and there is no doubt that if such teaching were more general, the necessity for specialised instruction would be lessened, and a great part of the technical teaching of evening students might be remodelled. Dr. Armstrong scarcely did justice, however,

[1] Report of Proceedings of the Fourth Meeting, held in London, June 1897.

to the good work now carried on in some of the London polytechnic institutions, which do not, as a fact, give any undue prominence in their teaching to the requirements of the Science and Art Department's examinations. Every one, however, will agree with him, that in the organisation of education some machinery must be found, whereby those, in whom the control of education is vested, are brought into contact "with those who are actively engaged in improving the methods of teaching, *i.e.* in educational research."

Of the papers dealing more particularly with technical education in relation to trade subjects, that of Mr. Sidney Wells, on the qualification of teachers, will be read with most interest. He recommends the attachment to trade classes, of student-teachers who would be required to follow a course of instruction covering two or three years. The students would be selected from the members of separate trades, and would be remunerated by scholarships for the loss incurred during the period of their training. The means of providing a suitable training for trade teachers is a serious question that must be faced before long. In many of our trade classes, as now conducted, there is a lamentable waste of energy and money owing to the want of previous education of those who *faute de mieux* are appointed as instructors. A paper on "Theory and practice in trade teaching" deals with the same question from another point of view, showing the difficulties inherent in the teaching of trade subjects, as regards both the instruction to be given in the principles of science applicable to a particular trade, and the use of tools and machinery in workshop practice. In the discussion that followed the reading of these papers, and of others bearing incidentally upon the same subject, no serious attempt was made to grapple with the real difficulties of the problem. As might have been expected, there was considerable divergence of opinion as to whether technical instruction should be limited to the section of the trade in which the student is actually engaged, or should extend beyond it—a question which is unavoidably complicated by trades-union considerations. Mr. Steward, of the Central School of Arts and Crafts, in reference to the gold and silver trades, expressed his opposition to the system prevailing at the Vittoria Street School, Birmingham, where lads are encouraged to practise in the school other branches of the trade than the one at which they daily work. On the other hand, Prof. S. P. Thompson quoted with approval a passage from a report of the Technical Education Board to the effect, that at the Crafts School every effort was made "to give students a broader view and practice of the craft in which they are engaged"; and he exemplified his meaning by suggesting that silver chasers might be required to learn some other branch of the trade, such as engraving or enamelling. No fault can be found with many of the general principles enunciated in connection with trade teaching. That "all Technical Education Boards should negotiate with trade organisations with a view to co-operation"; that "technical education means a different thing in every trade or group of trades"; and that "all teachers of technical classes should be practical craftsmen," are propositions generally admitted. But, as regards teachers, we have already seen that the qualification of practical craftsmanship is not alone sufficient, and the difficulty arises in finding, united in the same person, the combination of qualities now needed.

No educational congress could be held in England without frequent reference to the subject of examinations. Questions of organisation and control, the influence examinations exercise, or might be made to exercise, on teaching, were very fully discussed. Prof. Wertheimer, speaking as a teacher, said: "There are not a few of us who would be prepared to make the establishment of a new examination a misdemeanour, unless the examination took the place of one or more already in existence." A few good suggestions were made in the course of the discussion for the better coordination of examining bodies, but progress in this direction can scarcely be looked for until the passing of a satisfactory bill for organising secondary education.

Mr. Quintin Hogg read an interesting paper on the new polytechnics of London, and Dr. Garnett referred in detail to the efforts made by the London County Council to place the instruction given in those schools on sound educational lines. The appointment of an educational principal to each school, the insistence on practical teaching in the laboratory or workshop, the encouragement of special advanced studies suitable to each locality, and the establishment of an efficient system of inspection, are evidence of the thought and care bestowed upon the direction of these institutions. They are still, however, in an experimental stage of existence; but in the provision they afford for secondary technical instruction, particularly of that kind adapted to evening students, they serve to indicate the great progress that has been made during the last five years.

Among the descriptive papers contributed by foreign delegates, that of Herr von Deifenbach, on the system of instruction in Würtemburg, would claim first consideration, if space permitted us to enter upon this group of subjects. None of these communications, however, add much to the information already furnished in the reports of various Commissions, and in the articles on foreign schools that have appeared from time to time in these pages, and in those of other journals.

The question of commercial education was fully discussed by several speakers, including M. Siegfried, Mr. Hewins, Mr. Sidney Webb, and Mr. Organ. The cry for commercial education, when carefully defined, seldom means more than a demand for the systematic teaching of modern subjects in our secondary schools. A course of French and German intelligently taught, lessons in scientific method illustrated by laboratory work in chemistry and physics, instruction in practical mathematics with graphic exercises, and lectures on history with explanations of the growth and routes of trade would satisfy most of the requirements of those who attach value to commercial education; and schools giving such a training will probably be found in every large town, when our secondary education is fairly organised. In connection with this subject, attention may be called to a report on commercial education in Europe recently issued from the Bureau at Washington. Dr. James, the writer of the report, tells us: "There is no institution in Great Britain, which fairly deserves the name of a commercial high school. . . . England is now beginning to wake up to the necessity of this sort of education. Boards of trade, teachers' conventions, educational societies, have all begun to agitate for its introduction." And, later on, he says: "Instead of taking hold of the subject at the right end, and organising a great institution in London, which might serve as a model for such schools elsewhere, the English began their work in this field, as in many similar instances, by establishing examinations." We feel the force of this criticism; but it is a question, to be carefully considered, whether high schools of commerce, similar to our science colleges, are really needed in this country, for the training of youths between the ages of eighteen and twenty-one in the details of office work. In their papers dealing with this question, Mr. Webb and Mr. Hewins have contributed to the better apprehension of the difficulties of the subject. As pointed out by one of these writers, the highest commercial instruction must be specialised to prove useful and attractive, and it should appeal to those engaged in the particular branch of commerce to which it refers.

We cannot close this short notice of the subjects con-

sidered at the Congress without reference to the papers on domestic economy. It must be admitted that the teaching of such subjects as cookery and laundry work has been made of late years distinctly more educative, and at the same time more practically useful. Much of this improvement is undoubtedly due to the educational experiments carried out by Mr. Hugh Gordon and by Mr. Heller, under the direction of the London School Board. The results of their work may be seen in the training schools attached to some of the polytechnics, and in the classes held in other institutions. Miss Walter's paper on "Domestic science as an element in girls' education" shows the great advance that has recently been made in the treatment of this important subject, and marks the distinction, not always clearly indicated, between the teaching of domestic science and of domestic arts. For persons qualified to give instruction in the science there is an increasing demand; and in her paper, Miss Walter gives an outline of the course of training such persons should undergo, and her suggestions do not err on the side of incompleteness.

It is doubtful whether the bulky volume, the contents of which we have endeavoured to summarise, will be read by many, even of those persons who are actually engaged in the work of technical education. Such congresses, however, serve a useful purpose in bringing people together for the interchange of opinion, and in inducing a few persons to think seriously on some of the difficulties which, owing to its wide meaning and the variety of its methods, the problems of technical education undoubtedly involve.

MICROSCOPIC STUDY OF ALLOYS.

THE study of metals with the microscope proceeds apace, and is now becoming as generally pursued among metallurgists as the determination of melting points has been during the last five years. Since the appearance of Prof. Roberts-Austen's article on "Micrographic Analysis" (NATURE, vol. lii. p. 367, 1895) of iron and steel, a large amount of work has been done; but most observers still devote themselves more or less exclusively to the study of this metal, attacking unsolved problems which seem to have great industrial importance. This tendency is unfortunate from some points of view, for the complex constitution met with in that protean element makes it less easy to explain the observed appearances until, by work on simpler alloys, a better acquaintance with the whole subject has been obtained. M. Charpy is one of those who has resisted the temptation offered by the alloys of industry, and in a recent paper [1] has given some interesting results of his investigations on binary alloys which are well worth re-statement.

It is now fairly established that microscopic examination gives an immediate analysis of alloys, which is all the more valuable for differing in its results from chemical analysis, since these differences indicate the existence of definite compounds, and elucidate the structure in other ways. The immediate analysis is now made with the aid of a planimeter, as Sauveur recommended, by which the ratio of the areas occupied in the microscopic field by the various constituents can be measured. The metal or metals forming each of these constituents can often be indicated by their colour, hardness and, above all, the effects on them of various reagents, and thus a full account of the alloy can be given.

In the normal type of constitution of binary alloys, crystals of one of the metals, or of a definite compound of the two, are seen enveloped in a second constituent, which is generally the eutectic alloy, containing both elements in a very finely-divided state. The composition of the eutectic mixture remains constant, whilst the amount of isolated crystals varies with the percentage composition of the alloy. The limiting cases of a pure definite compound or metal, and of a pure eutectic mixture may be grouped with these alloys.

Eutectic alloys vary in appearance according as they have been cooled slowly or quickly. In the latter case, the surface is uniformly striated, but the crystals or crystallites are so small, that it is difficult to obtain satisfactory photographs of them. When the solidification is slow, however, the separation into lamellæ is strongly marked, especially when viewed under high powers, and this structure is highly characteristic of eutectic alloys, being easily traced in any of them whatever the metals in the alloy may be. It is well shown in Fig. 1, which represents an alloy containing silver 66 per cent., antimony 34 per cent., magnified 500 times; the metal has been treated with sulphuretted hydrogen, which has blackened the silver and left the antimony unchanged.

FIG. 1.—Alloy of silver, 66 per cent.; antimony, 34 per cent.

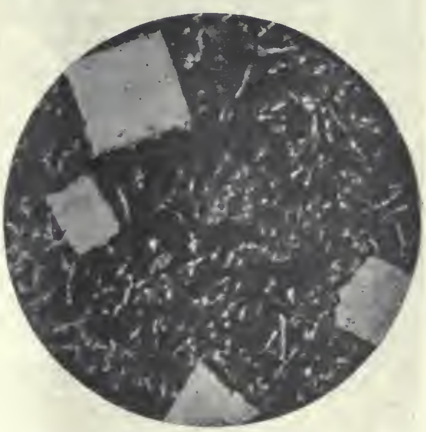

FIG. 2.—Alloy of tin, 90 per cent.; antimony, 10 per cent.

In the same figure some straight edges can be seen, in which the ramifications end, and which sketch out shapes resembling those of crystals of antimony. The presence of these crystallites or incipient crystals in eutectics constitutes one of the resemblances between them and the micro-felsitic basis observed in many igneous rocks, and it seems likely enough that if light transmitted through these alloys could be examined, it would show that they are on the borderland between crystalline and amorphous matter.

[1] "Étude Microscopique des Alliages Métalliques. *Bull. de la Soc. d'Encouragement*, vol. ii. (1897), p. 384.

Besides the normal type of binary alloys, in which eutectics are observable, there is a second type consisting of alloys of metals which form isomorphous mixtures with each other. These alloys, whatever may be their composition, consist of only one species of crystals, which fill the whole space, the composition and the properties of the alloys usually varying in a continuous manner in each crystal. The number of metals capable of forming

FIG. 3.—Alloy of tin, 75 per cent.; antimony, 25 per cent.

isomorphous mixtures with each other is small, the bismuth-antimony alloys being the only ones out of fourteen series investigated by M. Charpy in which this property was found to exist, but, on the other hand, there are many cases of definite compounds of two metals isomorphous with one of them. Thus, for example, microscopic study has enabled M. Charpy to detect a compound of tin and antimony containing about 50 per

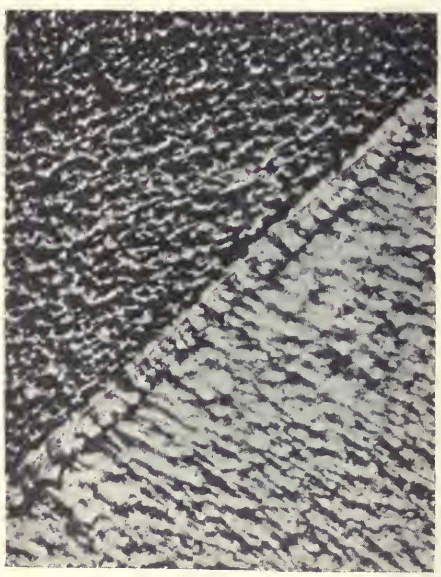

FIG. 4.—Pure gold. × 1000 diameters.

cent. of tin and isomorphous with antimony, although the freezing-point curve, worked out by Roland-Gosselin, and consisting of three branches having their concavities upwards, and meeting in two angular points or maxima, gives no direct indication of the relation between these metals.

In Fig. 2, in which the alloy containing 10 per cent. of antimony is shown, the cubical crystals appear to consist of the 50 per cent. alloy set in a eutectic magma. Fig. 3 shows the alloy with 25 per cent. of antimony. As the proportion of antimony in the whole mass approaches 50 per cent., these crystals invade the whole field, and numerous minute cracks appear, on the edges of which is seen a secondary crystallisation without the interposition of an intermediate substance. This structure is characteristic of a pure or homogeneous substance, as in the beautiful micro-sections of pure gold prepared by Osmond and Roberts-Austen,[1] one of which is reproduced in Fig. 4. When the proportion of antimony is increased above 50 per cent. a eutectic magma shows no signs of reappearing. Similarly in the tin-antimony series, there is evidence of a compound containing 20 per cent. of antimony and isomorphous with silver, and in the silver-tin series a compound containing 30 per cent. of tin also appears to be isomorphous with silver. An investigation of the triple alloys of these metals would be interesting, as probably affording fresh examples of isomorphous series.

T. K. R.

NOTES.

THE Municipal Council of Paris has made a grant of three thousand francs to the fund for the erection of a statue of Lavoisier in Paris.

M. MOUREAU has found in the records obtained at the Parc-St.-Maur Magnetic Observatory, a distinct disturbance evidently produced by the Indian earthquake of June 12. The exact time of the magnetic perturbation registered on that day is 11.37 a.m.

AT a recent meeting of the Durham and Northumberland Archæological Society it was unanimously resolved to obtain a portrait of the president, the Rev. W. Greenwell, F.R.S., Canon of Durham, to be placed in the Cathedral Library, Durham. A strong committee has been formed to further this object, and more than one hundred guineas have already been paid or promised. Further subscriptions are invited, and will be received by Mr. C. Rowlandson, at Messrs. Hodgkin's Bank, Durham, or by Mr. J. G. Gradon, Lynton House, Durham.

SIR RUTHERFORD ALCOCK, formerly president of the Royal Geographical Society, died on Tuesday, at the age of eighty-eight. The death is also announced of Prof. C. E. Colby, professor of organic chemistry in Columbia University.

DR. G. H. OTTO VOLGER, who died at Sulzbach, in the Taunus, on October 18, aged seventy-five, was at one time a notable figure in scientific and political circles in Frankfurt. A many-sided man, he contributed during his life a number of miscellaneous papers to various natural history and philosophical societies. He made several original contributions to geology, and wrote on the origin of springs, and on meteorological and mineralogical topics. During the time of his greatest activity, while resident in Frankfurt, he founded a society for the cultivation of sciences and arts called the "Freies deutsches Hochstift." Nearly forty years ago, when the old residence in the Hirschgraben, where Goethe was born, came into the market, he bought it. For a time he lived in it, with the direct object of gradually restoring it, room by room, to the state in which it existed (as described partly in *Dichtung und Wahrheit*, and partly in *Wilhelm Meister*) during the boyhood of the poet. This done, he made over the Goethe-house to the Hochstift, of which he was then, and for twenty-two years, the president.

[1] Osmond and Roberts-Austen, "On the Structure of Metals, its Origin and Changes," *Phil. Trans.*, vol. clxxxvii. (1896), A., pp. 417-432.

After Frankfurt had ceased to be a free city, and imperial ideas swept over the old place, Dr. Volger found himself increasingly out of harmony with the new *régime*, and he withdrew from Frankfurt, first to Soden and lately to Sulzbach. In accordance with his express wish, his funeral at Frankfurt, on the 20th ult., was strictly private.

WE have received the Year-book of the Cambridge Philosophical Society, containing the addresses of the Fellows of the Society, and a list of the English and Foreign Societies with whom the publications of the Society are exchanged. It would appear that the Society is a convenient meeting-ground for Cambridge men engaged in scientific work. Papers for presentation to the Society are received by the Secretaries at the library of the Cambridge Philosophical Society, Cambridge. The Proceedings are published three times yearly—the publication of the Transactions is to be accelerated: the meetings are held every fortnight during full term. The following is a list of the new honorary members, elected May 24, 1897:—Major Macmahon, R.A., Prof. Charles A. Young (Princeton), Prof. Michelson (Chicago), Dr. Boltzmann (Vienna), Prof. Righi (Bologna), Prof. Mendeléeff (St. Petersburg), Sir Archibald Geikie, Prof. Dana (New Haven, Conn), Sir John Kirk, Prince of Monaco, Rev. Canon Norman (Durham), Prof. Wilhelm Pfeffer (Leipzig).

AN instructive fisheries exhibition, arranged to illustrate the fishing industries and the application of science to agriculture, was opened in the Zoological Museum of the University College, Liverpool, on Friday last. The exhibits are fully described in a guide to the exhibition published by the authorities. There is a series of the food fishes of this district, with the more important food matters of each; also a series of useful and useless fishes which compete with one another by eating the same food. Another exhibit contains specimens of the shell-fish of the district, showing stages in the life-history and growth, legal and illegal sizes, pearl formations, and pearls. A case is devoted to a display of printed matter, plates, photographs, drawings, and lantern slides, illustrating the publications, both administrative and scientific, of the Lancashire Sea Fisheries Committee, and other work bearing upon the fisheries of the district. The drawings and sketches include a number made by Prof. Herdman in illustration of his joint investigation with Prof. Boyce on the diseases of oysters and the connection between the oyster and disease. The exhibition will no doubt promote a more widespread interest upon the important question of sea-fishing, and thus assist in increasing the harvest of the sea. As Prof. Herdman pointed out at the opening ceremony of the exhibition, fishes are animals, their food is composed of animals, and their enemies are animals. In all the operations of their life, their feeding and breeding, and so on, they are subject to the same biological laws which regulate the lives of all animals in the sea. The investigation of fishery questions is applied biology, and if our fisheries are to be benefited they must be treated in a scientific manner. We do not trust to unaided nature for our supplies of bread-stuffs and beef. Why then should we trust to nature for fish? As there is an agriculture of the land, so there must be an aquiculture of the sea. Fishermen must in the future be farmers of the sea-shore, not hunters as they have been in the past.

SIR J. WOLFE BARRY, in an address at the opening of the new session of the Institution of Civil Engineers on Tuesday, said that the Institution now numbers on its roll 7075 persons. Reviewing the subject of the examinations recently instituted, he pointed out that they are intended to show that candidates for election into the class of Associate Members are acquainted with those general principles which have always been and must be recognised as the basis of the engineering profession, and also to make clear that each candidate possesses a somewhat fuller scientific knowledge of the elements of the particular branch in which his special training has lain. Practical knowledge is no less necessary now than formerly; for the examinations have not been instituted in lieu of other qualifications set out in the by-laws, but in addition to and supplementary of them.

WE have received the Report on the Administration of the Meteorological Department of the Government of India in 1896 97. It is divided into two parts; the first gives a general account of the results during the past year, and the second gives details of administration, chiefly in the form of tables. In the branch of marine meteorology two clerks have been regularly engaged in collecting data from ships visiting Calcutta and Bombay, and more than two thousand logs have been extracted. The observations are tabulated day by day, and are utilised in the preparation of charts of the Monsoon area. Observations have been made for some years past in certain forest areas with reference to the influence of forest-growth upon the distribution of rainfall, but have now been discontinued. Photogrammetric cloud observations have been regularly made since March last at Calcutta and Allahabad with the best type of instruments, which were constructed in Paris. Storm warnings are issued when necessary, partly from Calcutta and partly from Simla, and timely notice appears to have been given of all the more important disturbances. Among the various useful publications, we may mention the printing of the hourly observations formerly made at Trevandrum, under the superintendence of the late J. Allan Broun. The work of publication of the hourly values is now completed, and Mr. Eliot has undertaken their discussion, from which we anticipate some valuable results. He hopes to complete it during the present year.

A RECENT number of the Cape of Good Hope *Agricultural Journal* contains an important report on rinderpest by three Russian investigators, M. Nencki, N. Sieber, and W. Wyznikiewicz. These gentlemen were appointed by the Russian Government two years ago, to study how far sheep of the Merino family are subject to rinderpest, and at the same time to investigate the nature of the contagium of this disease. Their inquiries were carried on first in the Kuban-Cossack country, and later at the Institute for experimental medicine in St. Petersburg. They claim to have discovered the genuine contagium of rinderpest, which does not belong to the bacterial class of germs, but appears to partake more of the character of the amœba. After experimenting with about a hundred different media, in the hope of separating out the specific rinderpest agent, their efforts were rewarded by the discovery of "slightly luminous bodies in size from 1–3 μ, mostly round, a few being oval, pear-shaped, or drawn to a point. On the larger ones swellings may be seen, and, in a few, a grain lying in the centre. The larger and duller individuals show amœboid developments; some also have one, seldom two, ciliated protrusions." With fresh cultures of these organisms the rinderpest can be generated. Such cultures, however, are very perishable, and it is recommended to re-inoculate the culture daily. The best material for the cultivation of these organisms is apparently that which is rich in animal mucus, and by employing solutions containing an abundance of mucine, the authors succeeded in at length obtaining them in a living condition outside the animal's body. Great difficulty was experienced in ensuring the virulence of rinderpest cultures, but this trouble has to a considerable extent been overcome. "All organs and juices of diseased animals contain the rinderpest germ," the authors assert; and now that their methods have been brought before the scientific world, it only remains for other investigators to repeat and, we trust, confirm the important results which have been obtained.

THE first number (November) of the new volume of the *Century Magazine* contains several contributions of scientific interest. Prof. H. F. Osborn writes an appreciative notice (accompanied by a portrait) of the late Prof. Cope. Shortly before his death Prof. Cope communicated to Mr. W. H. Ballou a number of interesting views which he held as the result of many years' study of the skeletons of Saurians, or lizard-like reptiles, found in various beds of the Rocky Mountains and other regions of the United States. He had arrived at some original and ingenious speculations with regard to the structures and habits of these animals, and, in addition, he completed the evolution of the carnivorous line of Saurians. Mr. Ballou now presents these views in an interesting article containing several vigorous illustrations, in which Mr. Knight well conveys Prof. Cope's impressions of how ancient Saurians lived and moved.—Mr. Jonas Stadling, who witnessed the start of Herr Andrée's balloon expedition towards the north pole, contributes to the *Century* a short description of the preliminary arrangements, accompanied by several reproductions of photographs of the balloon when beginning its journey. Mr. Stadling states that the balloon lost about fifty cubic metres of gas every twenty-four hours when it was standing filled in the balloon-house, from which rate of escape of gas it is concluded that the balloon would float about thirty days.—Accompanying an article upon Mrs. Cameron and her photographs, in the *Century*, is a fine reproduction of her successful portrait of Sir John Herschel.

THE continually increasing difficulty of dealing with the sewage of large towns lends an interest to any scheme which appears to give satisfactory results in the purification of the effluent from the sewers so as to render it fit to flow into the rivers without polluting the water, and creating a nuisance. So great is the difficulty and cost of purifying the sewage up to the required standard, that Manchester has been advised that the only practicable way of disposing of the effluent from the sewage tanks, which now flows into and pollutes the Ship Canal, is by constructing a culvert fifteen miles long for the purpose of conveying it to the estuary of the Mersey at a cost of 258,000*l.*, and it is intended to apply to Parliament in the ensuing session for the necessary power to carry this work out. The sludge from the tanks is to be taken out to sea. The County Council of London employ a fleet of six steamers which are regularly engaged in conveying the sludge deposited in the outfall tanks at Barking and Crossness a distance of fifty miles to Barrow Deeps at an annual cost of 32,000*l.*; the material so removed amounting to over two million tons a year. At Exeter a new system of "septic" treatment has been tried, and it is described by Mr. Cameron, the City Surveyor, in a paper read before the Devon and Exeter Architectural Society. It is claimed for this system that the sewage treated by this process in the tanks is brought under the influence of micro-organisms; the decomposition of the matters which would otherwise undergo putrefaction being effected by the presence of these micro-organisms, their products being ammonia and carbonic acid with some other gases. The bottom of the tanks after six months' use, when exposed, showed only a thin layer of black earthy matter, together with mud and grit. The effluent is not offensive, and it is stated that it does not ferment. At Wolverhampton recent experiments have shown that filtering the sewage through coal-dust is an effectual way of purifying it, and that a very satisfactory effluent can be obtained by passing 200 gallons of sewage through one square yard of filtering material in twenty-four hours.

THE interest of the many recent observations of earthquake-pulsations has led Dr. M. Baratta, who is preparing a history of seismology, to search for early accounts of these phenomena in various scientific works. He has succeeded in discovering several forgotten records, which are described in a paper in the *Rivista Geografica Italiana* (1897, fasc. viii.). Those of pulsations observed with magnetic apparatus date back to 1681, with astronomical instruments to 1767, and with levels to 1833. Dr. Baratta's examples are taken from French and Italian sources; and it can hardly be doubted that others, equally interesting, would be obtained from an examination of English and German works.

IN an interesting and well-illustrated little memoir on "L'Echelle réduite des expériences géologiques," in the *Revue de l'Université de Bruxelles*, M. W. Prinz sets himself to answer the question whether experiments conducted to explain geological phenomena become untrustworthy on account of the small scale and different materials with which they are necessarily performed. His answer is decisively negative. The results of experiments like those of Cadell on the production of planes of major and minor thrust are exactly similar to those produced in the planing of steel, the difference in scale between the two classes of experiments being greater than that between Cadell's thrusts and those of the Highlands which they were intended to explain. With regard to difference of material results similar to those of Daubrée on plate-glass may be reproduced in mastic, cast-iron, modelling clay, and half-solid mortar; in all cases cracks similar to the joints and cleavage in rocks are produced. Again, the differential movement which makes marginal crevasses in glaciers may be imitated in the cutting of glass by a wheel, by drawing a needle over dry plaster, by a pencil on paper, by footsteps, or by dragging a cane over thick snow, and even by moving a cart-wheel over a muddy road. Further instances, including the action of a diamond on glass, and a bibliography, conclude this interesting memoir.

MR. ALBERT F. WOODS, of the Division of Vegetable Physiology and Pathology, United States Department of Agriculture, describes in the *Botanical Gazette* a novel method of preserving the green colour of plants for exhibition purposes. The principle involved is to bring about a combination of the chlorophyll in the cells of the plant with copper. The resulting compound, copper phyllocyanate, is practically insoluble in any of the ordinary preserving media except strong alcohol, and is not destroyed by light. The resulting green can scarcely be distinguished from the normal chlorophyll green. The process described is a somewhat complicated one. After removing the air as completely as possible from the surface and from the intercellular spaces by immersion in 90-95 per cent. alcohol, or by means of the air-pump, the tissues are placed in a 5 per cent. solution of glycerol containing enough dissolved copper sulphate or copper acetate to give it a bluish tint. The uncombined copper is dissolved out by a dilute glycerin-formalin solution, and the object may be preserved in this solution or in any of the usual media except strong alcohol.

THE number of printed specifications of patents in the Patent Office Library at the present time is well over a quarter of a million. To search through these specifications in order to obtain information as to the novelty of an invention is thus a tremendous task even for the trained expert; yet by omitting such a search many a patentee has found, after paying his fees, that his patent was worthless, because it had been anticipated; for the Patent Laws of this country make no provision for an official search as regards novelty, and all patents are taken out at the risk of the inventors. The searcher is, however, greatly assisted in his task by a series of indexes and abridgments published by the Patent Office as a guide to the specifications themselves, and freely distributed to the principal public libraries in this country. The abridgments give a general description of the nature of every invention patented, and the object of their publication is to enable the would-be patentee to carry out, at any rate in some

cases, what may be termed a fireside search. The volume containing abridgments of patents belonging to the class of *Philosophical Instruments*, and referring to the years 1884–88, has been sent to us by the Comptroller-General of Patents. In it we find concise descriptions (usually illustrated by diagrams) of optical, nautical, surveying, mathematical, and meteorological instruments and accessories. Some of the subjects of the patents are very trivial, while others are most ingenious; so an examination of the whole will be found amusing as well as instructive. The favourite scientific instruments upon which human ingenuity exercises its powers seem to be barometers, clinometers and other instruments for measuring vertical angles, magnetic compasses, hygrometers and hygroscopes, lenses, levels and plumbing instruments, logs and leeway indicators, magic-lanterns and other projecting apparatus, mathematical drawing instruments, microscopes, reflectors, protractors, sounding apparatus, spectacles and eye-glasses, surveying instruments, telemeters, thermometers and pyrometers, and stands for cameras and telescopes. The volume thus provides the material for a liberal education in the construction of scientific apparatus, in addition to which it is full of interest to every one with an inventive turn of mind.

IN the current number of the "Annotationes Zoologicæ Japonenses" Mr. Nishikawa describes a newly-discovered mode by which the eye of the lower side of a flatfish travels round to the upper side during metamorphosis. Agassiz observed that in the majority of flatfishes the eye of the (eventually) blind side travels round the dorsal edge of the head until it attains its final position, and that not until this rotation is completed does the dorsal fin grow forwards beyond the level of the eyes. In *Plagusia*, on the other hand, the dorsal fin is known to grow forwards to the snout while the eyes are still symmetrical, and the right eye attains its final position on the left side of the fin by penetrating, in the course of its rotation, through the soft tissues at the base of the fin. In the fish observed by Mr. Nishikawa the dorsal fin also grows forward before the rotation of the right eye, but this anterior extension does not unite with the head until after the rotation is completed. Its ventral margin is contiguous with the dorsal surface of the head except posteriorly where there is a distinct hole, bounded by the head and the anterior extension of the fin, for the passage of the right eye, which thus travels round the dorsal side of the head without sinking into its tissues. It is clear, as Mr. Nishikawa points out, that the mode by which the change of position is effected in this fish is intermediate between that observed in ordinary flatfishes, which are destitute of an anterior extension of the dorsal fin at the time of transformation, and that which is exhibited by *Arnoglossus* and *Plagusia*, in which types the anterior extension of the fin coalesces with the head before rotation of the eye, and requires to be perforated for the passage of that organ. The genus of the Japanese fish could not be ascertained with certainty, but it is believed to be closely related to the genus *Plagusia*.

THE forty-third annual report dealing with the work of the Australian Museum, Sydney, during the year 1896, has just come to hand. The most important presentations to the Museum during the year was the Dobroyde collection of Australian birds and eggs, containing several thousand skins and eggs—the result of forty years collecting. This was purchased by the Government of New South Wales from Mr. J. S. Ramsay, and transferred to the custody of the Trustees of the Museum. Another valuable donation is a mass of meteoric iron weighing, just over 44 lb., found on the Nocoleche Holding, near Wanaaring, New South Wales, and presented to the Museum by Mr. G. J. Raffel. The semi-fossil remains of a Dugong, discovered in the excavations for a canal, near Sydney, have also been presented to the Museum. This is the first instance of the discovery of Dugong remains so far south. Among other noteworthy acquisitions are: The bower or playground of Newton's Bower-bird (*Prionodura newtoniana*), types of the Honey-ants of the Horn Central Australian Exploring Expedition, and a further collection of bird skins from the same, some ancient Peruvian urns, a collection of Australian Coleoptera, and the remains of the Asiatic elephant Jumbo. Mr. Charles Hedley, one of the officers of the Museum, who was permitted to accompany the Royal Society's Coral Reef Boring Expedition, succeeded in amassing an interesting collection during his stay on Funafuti, particularly of invertebrate and ethnological subjects. The collections are now in process of description by the scientific staff of the Museum. A commencement has been made at the works for extension of the Museum buildings, for which a sum of 6000*l.* was voted by the New South Wales Parliament in 1895. The old ant-eaten roof has been removed, and a new roof, built of steel, wood and copper, has been constructed. While this was in progress a thorough inspection of the building was made to ascertain the extent of the ravages of the "white ant," with the result that further depredations were discovered. These terrible termites were found to have penetrated under the floor of the ethnological hall, and completely destroyed the woodwork of that structure as of the roof. It is not surprising to read that discoveries of this kind gave the curator, Mr. R. Etheridge, jun., plenty of cause for anxiety during last year. The chief change in the staff of the Museum is the appointment of Mr. W. J. Rainbow to succeed the late Mr. F. A. A. Skuse as officer in charge of the entomological collections.

THE difficulty of the problems which await the investigator into the chemistry of the enzymes is well illustrated by the results, published in the current *Berichte*, of an attempt made by A. Wroblewski to isolate diastase. The greater part of the substance usually known as diastase was found to be a carbohydrate, which yielded arabinose when boiled with acids. The active constituent, on the other hand, was found to have all the properties of a protein, although the author could not be sure that he had prepared it in an absolutely pure state. The proteid nature of the enzyme follows from the facts that the residue left after removing the inactive carbohydrate shows all the characteristics of a proteid body, and at the same time exerts the diastatic action on starch. This research affords, for the first time, a definite experimental basis for the enrolment of this enzyme among the proteids, although many investigators had taken this view of its nature on general grounds.

THE *Bulletin* of the Bussey Institution, vol. ii. part 6, published under the authority of Harvard University, consists of a paper by Prof. F. H. Storer, on some of the chemical substances in the trunks of trees, which serves to show that other substances besides starch are stored up in large quantities as reserve food-material in the winter, to be converted into sugars in the spring.

THE additions to the Zoological Society's Gardens during the past week include a White-crested Tiger Bittern (*Tigriosoma leucolophum*) from West Africa, presented by Dr. J. F. Dell; an Alligator (*Alligator mississippiensis*) from Southern North America, presented by Mr. J. H. Renals; a Common Chamæleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. G. E. Gratton; two Great-billed Rhea (*Rhea macrorhyncha*) from North-east Brazil; a Pennant's Parrakeet (*Platycercus pennanti*) from Australia, deposited; six Common Rhea (*Rhea americana*), bred in Holland; a Many-coloured Parrakeet (*Psephotus multicolor*) from Australia, purchased; a Sambur Deer (*Cervus aristotelis*, ♀), a Hog Deer (*Cervus porcinus*, ♀) from India, received in exchange; three Shaw's Gerbilles (*Gerbillus shawi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE PHOTOGRAPHY OF FAINT MOVING CELESTIAL OBJECTS.—An ingenious but simple method of photographing unseen or very faint moving but known celestial objects has recently been suggested by Prof. Barnard (*Astr. Nachr.* No. 3453). Every one knows that in order to photograph a faint celestial object, it is only necessary to prolong the exposure until a sufficiently burnt-out image is recorded on the photographic plate. If, however, the object has a rapid motion, then the image will not remain on one part of the plate a sufficiently long time to record its impression, since the clockwork of the instrument is regulated to counterbalance the apparent motion of the stars. Prof. Barnard's idea is to use, in the eyepiece of the guiding telescope for following the object in question, two guiding cross wires attached to a light frame which can be moved by a delicate clockwork (the works of an ordinary watch are sufficient), the speed of which can be regulated to the motion of the object. Arrangements can also be made that its direction of motion can be regulated to any position-angle. When adjusted to the eye end of the guiding telescope, the instrument is set so that the amount and direction of motion of the cross wires shall coincide with that of the comet or minor planet.

A star in the field of view is then bisected by the cross wires, and the mechanism set in operation, the star being kept bisected by the ordinary slow motions for star guiding. It will thus be seen that although the operation is exactly the same as if the star itself were being photographed, it is the image of the comet which will remain stationary as regards the photographic plate, while the stars will produce trails. Prof. Barnard mentions that the device will be very serviceable for photographing visible comets with ill-defined nuclei, as these have no definite points to guide by, and it is for this work that he is going to have an instrument of this kind made.

SUNSPOTS AND THE WEATHER.—Although nearly every one is agreed that sunspots do influence our weather, the relation between them is evidently not a very simple one. Statistics of the weather from places situated in moderate latitudes do not, at any rate, bring out very clearly direct indications of such a connection; but when they are gathered from a large region near the equator, such as India, then the effect of the sunspot cycle on the weather is more decisive. The first effects of solar disturbances would be felt at the equator, and as the mean temperature does not vary very much from the extremes, a general small increase or decrease would make itself apparent. In more northern latitudes local disturbances seem to tend to a great extent to mask the effects of a variation in the amount of solar radiation.

Mr. Alexander MacDowall has, however, examined a number of weather statistics from several European stations—viz. Bremen, Paris, Geneva, Greenwich—and he finds that they are suggestive of a relation to the sunspot cycle (*Quarterly Journal of the Royal Meteorological Society*, vol. xxiii. No. 103).

In making out his curves he says he has used smoothing methods freely, sometimes smoothing with averages of five and sometimes with additions of five. In this investigation the author has compared corresponding portions of successive years, such as the winter half, summer half, the four seasons, &c. To sum up the inquiry in his own words, he says: "In the climate of Western Europe there is apparently a tendency to greater heat in the summer half and to greater cold in the winter half near the phases of minimum sunspots than near the phases of maximum; the contrast between the cold and heat of the year thus tending to be intensified about the time of minimum sunspots. . . . If we accept the view to which direct observation of the sun seems to lead, that solar radiation of heat is greater about the time of maximum sunspots, we appear to have a direct explanation why, on the one hand, our winter cold should thus be moderated; and as to the contrary effect in the summer half, it is not difficult to conceive that solar activity may, by increased evaporation, bring about the presence of more cloud, and so give us cool, rather than hot, summers."

The conclusions drawn by Mr. MacDowall are exactly what would be expected, and they corroborate those that were formed many years ago. Thus, for instance, in a pamphlet published in 1879, and submitted to the Indian Famine Commission, we read: "For it is an acknowledged and readily accountable fact that presence of cloud in the summer is associated with coolness, and in the winter with warmth; and in like manner that a clear sky, which in the summer, by promoting solar radiation, favours the development of great heat, in the winter, by giving free scope to terrestrial radiation (in the then comparative absence of solar radiation), tends to produce excessive cold. The fact, therefore, that clouds are more prevalent in the *summers* of maximum sunspot years, and in the *winters* of minimum sunspot years, is only another way of saying that both summer and winter are *cooler* at the former epoch and *warmer* at the latter."

COMET PERRINE, OCTOBER 16.—The following is a continuation of the ephemeris of this comet, computed by Herr. J. Möller (*Astr. Nachr.*, No. 3454) from the observations of October 16, Mount Hamilton; October 18, Strassburg, and October 20, Hamburg (two observations).

12h. Berlin M.T.

1897.	R.A. h. m. s.	Decl. ° ′	log r.	log Δ.	Br.
Nov. 7 ...	19 25 54 ...	+75 21·9 ...	0·1563 ...	9·9387 ...	1·0
8 ...	15 59 ...	74 19·4 ...	1550 ...	9429 ...	1·0
9 ...	7 31 ...	73 17·0 ...	1537 ...	9473 ...	1·0
10 ...	19 0 19 ...	72 15·0 ...	1524 ...	9517 ...	1·0
11 ...	18 54 10 ...	71 14·0 ...	1512 ...	9563 ...	1·0
12 ...	48 51 ...	70 14·1 ...	1500 ...	9609 ...	1·0
13 ...	44 13 ...	69 15·4 ...	1488 ...	9656 ...	1·0
14 ...	40 10 ...	68 18·0 ...	1477 ...	9703 ...	0·9
15 ...	36 36 ...	67 22·0 ...	1466 ...	9751 ...	0·9
16 ...	18 33 30 ...	+66 27·5 ...	0·1456 ...	9·9799 ...	0·9

The following comments relate to the appearance of this comet:—

Karl Mysz: 6-inch refractor in Pola. October 18, comet 10 mag.; axis of tail, 200°; nucleus appears sometimes double or oblong. October 19, same appearance and brightness as yesterday; nebulosity has diameter of 5′.

J. Möller: 8-inch refractor in Kiel. October 20, nucleus 10·3 mag., oblong and hazy; fan-shaped tail of about 2′ in length, having a position angle of 200°.

Schorr and Ludendorff: Hamburg refractor. October 20, comet has faint nucleus, 10·5 mag.; tail, 0′·5 towards south. October 24, fainter than October 20; no distinct nucleus.

Picart: at Bordeaux, October 20. The comet has a very feeble tail; its general form is that of an elliptical nebula.

THE DIRECTOR OF THE LICK OBSERVATORY.—We regret to read in the *Astronomische Nachrichten* (No. 3454) that, after a continuous connection with the Lick Observatory for twenty-three years, and a service at Mount Hamilton since the year 1888, Prof. Holden has resigned his post, and will terminate his official relations with the Observatory December 31, 1897. His address after October 1 will be Smithsonian Institution, Washington.

RELATION BETWEEN INDIVIDUAL AND RACIAL VARIABILITY.[1]

MR. BREWSTER'S memoir refers to "allied races" without defining that phrase, but apparently basing it on the idea of divergent races sprung from a common source. The mean (or typical) characters of these races differing from one another, as individuals of the same race differ among themselves, two systems of variables exist in respect to each and every character: (1) a single system, referring to the means of the different races; (2) several separate systems, referring alike to the individual values of the same character; in each and every race. He supposes the ordinary law of frequency to be approximately applicable to both systems, so that the peculiarities of every series admit of being roughly expressed by its own mean and quartile (=probable error). In order to reduce the variability of each series to a common scale, he works, not with the observed quartiles, but with what may be called *reduced quartiles*, namely the indices formed by dividing each quartile by its corresponding mean. These being comparable on equal terms, are his "measures of variability."

The first and more important part of the memoir deals with eighteen different characters in eight human races, the data being derived from Weisbach's *Körpermessungen*. The number of individuals in each of the selected races is unfortunately very small, ranging from eight to twenty-six, though he is able to

[1] "A Measure of Variability and the relation of Individual Variations to Specific Differences." By Edwin Tenney Brewster. (*Proc.* Amer. Acad. Arts and Sciences, May 1897.)

utilise twenty races for obtaining the common racial mean. His method of discussion is based on the safe ground that, if racial variability be associated with individual variability, whenever any specified character is more variable than another specified character in the one, it will (on the whole) be more variable in the other also. Therefore if the reduced quartiles of the two characters, in the series of means of races, be called A and B. and those in that of the individuals of any given race be called a and b, then if A be greater than a, B would (on the whole) be greater than b, and conversely. More briefly and fully, if the *signs* of the differences (A-B) and $(a-b)$ are alike, the evidence, so far as it goes, favours the suggested idea of a connection between racial and individual variability; if the signs are different it discountenances it.

The test is rough, but is of value when applied on a considerable scale with concurrent results, as in the present instance. The eighteen characters admit of $\frac{1}{2}(18 \times 17) = 153$ different pairs of combinations of the form $(a-b)$, in each of the eight races; that is 1224 pairs in all. Each of these has been compared with its associated pair in the series of means of races, of which there are altogether $\frac{1}{2}(8 \times 7) = 28$. The result is that in seven out of the eight races the cases testifying to the existence of the suggested association are from twice to thrice as numerous as the others, and in the eighth race they are $1\frac{1}{2}$ times as numerous. Nay more, there is some evidence that the most variable characters in the one, are the most variable in the other. This conclusion is corroborated by three other inquiries of the same kind, two into rodents and one into carnivoræ. The error introduced by the strained assumption, that the ordinary law of frequency holds good for the series of means of allied races, does not seem likely to invalidate the general conclusion to a serious extent. It therefore appears that Mr. Brewster has provisionally established his thesis that whenever any specified character varies much in individuals of the same race, it is probable that it will be found to vary much in "allied" races, and conversely.

ON THE CONSTITUTION OF THE ELECTRIC SPARK.[1]

IF a Leyden jar is discharged through metal electrodes, and the spectrum of the spark is examined, it is found that the metallic lines are not confined to the immediate neighbourhood of the poles, but are seen sometimes in the centre of the spark, several millimetres away from the electrodes, from which they must have been projected with considerable velocity.

It has always seemed to me to be a problem of interest, to measure the velocity of projection. A knowledge of it may teach us something concerning the mechanism of electric sparks and, in addition, we may hope to obtain information on some important points in spectrum analysis, which are at present under discussion. Thus, for instance, if the speed with which a molecule is pushed forward into the centre of the spark depends on molecular weight, we may separate from each other those lines of the spectrum which belong to different molecular combinations. For many years past I had made various unsuccessful attempts to deal with this problem, when I became acquainted with the elegant method, used by Prof. Dixon in some of his recent experiments, in which a photograph is taken on a film fixed to the rim of a rapidly revolving wheel, of which the speed may easily be made sufficiently large to measure velocities of moving luminous particles up to 2000 $\frac{\text{metres}}{\text{second}}$. This number might be doubled or trebled with improved appliances.

The experiments were conducted by Mr. Gustav Hemsalech, to whose care and skill their success is largely due. Without entering into a detailed description of the apparatus, it will be sufficient to say that the photographs, which I now submit to the Section, were taken on a film moving with a linear speed of about 80 $\frac{\text{metres}}{\text{second}}$ in a direction at right angles to the slit of the spectroscope. The lines of the metal appear inclined instead of straight, in consequence of the finite velocity of the luminous molecules. The air lines, on the other hand, though slightly broadened, remain straight. The sparks were taken from five large Leyden jars, charged by means of a Voss machine. Each single spark produces a good spectrum, reaching approximately from $\lambda = 5000$ to $\lambda = 4000$.

One of the photographs, in which zinc poles were used, shows that the velocity of the molecules is gradually diminishing as they move away from the pole. Close to it the speed seems very great, the average velocity up to a distance of about one millimetre being about 2000 metres per second. At a distance of four millimetres the speed is reduced to something like 400.

In another experiment one pole was zinc, while the other was bismuth. Some bismuth lines are found to be decidedly more curved than those of zinc, indicating a smaller velocity. But the line of bismuth, which lies at 4560, seems almost straight.

When the poles are moistened with a solution of calcium chloride interesting results are obtained, the calcium line at 4226 being more inclined than H and K.

The experiments were made with comparatively rough appliances, but a more perfect apparatus is in course of construction; and the author hopes to continue the research in conjunction with Mr. Hemsalech.

[1] By Prof. Arthur Schuster, F.R.S. (Read before Section A of the British Association at the Toronto meeting.)

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE section of Physiology at the British Association meeting at Toronto was a large and active one. Under the presidency of Prof. Michael Foster a large body of physiologists attended in about equal numbers from the east and west of the Atlantic. Meetings were held on the Thursday and Friday, August 19 and 20, and on the Monday, Tuesday and Wednesday, August 23, 24 and 25.

Among those present were Messrs. Bowditch, Boyce, Cushny, Crookshank, Gaskell, Halliburton, Huber, Huerthle, Lee, Loeb, Lombard, Billings, Lister, Macallum, Osler, Wesley Mills, Noël Paton, Porter, Waymouth Reid, Sherrington, G. N. Stewart, Anderson Stuart, Kellog, W. H. Thompson, Charles Richet, Waller, Welby, Shore, MacAlister, O. Grunbaum, Baldwin, Braun, Reynolds Green, Meldola, and A. S. Grunbaum.

Prominent among proceedings in the Section were the following:—

Prof. Bowditch read a paper on the physiology of unstriped muscular tissue as exemplified in the wall of the stomach of the frog. The rhythmic contractility of the tissue is well seen. When the organ or a strip of it is fitted to a recording apparatus, in the majority of instances after a lapse of not more than three hours, contractions of rhythmic recurrence are registered. Often two or more sets of rhythmic contractions are superposed. This may be best accounted for by supposing the muscle-cells to contract not all together but in two or more groups. In the discussion Prof. Sherrington referred to experiments published by him in which had been recorded contractions of the urinary bladder removed from freshly-killed monkeys and placed in warm normal saline solution, while connected with a volume recorder. In these the isolated bladder began to "beat" almost at once, and continued "beating" for an hour or less, at rate somewhat quicker than once a minute. The contractions thus obtained from the viscus only exceptionally displayed the compound character shown in Prof. Bowditch's curves.

Prof. Carl Huber brought forward observations on the cells of the sympathetic system of vertebrates. In Amphibia nearly all sympathetic cells are unipolar. In other vertebrates the prevailing type is multipolar. All sympathetic neurons have one axon only. The dendrites form a network between the cell-bodies of the neurons constituting a ganglion. The axon of each sympathetic nerve-cell becomes either a non-myelinated nerve-fibre (grey fibre) or a fine myelinated nerve-fibre. The fibres of the white rami are axons of cells lying within the spinal cord, and these axons reach the sympathetic ganglia through the white rami, and in the ganglia undergo branching, ending in baskets which enclose the perikarya of the sympathetic neurons. In mammalia and birds the circumcellular baskets are comparatively simple networks of varicose fibrillæ. In Reptilia and Amphibia instead of simple end baskets the fibre is spirally wound and completely contorted. This is the explanation of Beale's spiral fibre in the sympathetic cells of the frog figured by him forty years ago. In all vertebrates the pericellular baskets are intracapsular. Langley and his pupils have shown that an impulse travelling along a spino-sympathetic efferent chain may be blocked in a sympathetic ganglion by the injection of nicotin. This has been applied to practically all regions of the

sympathetic by studies carried out on Langley and Sherrington's pilomotor nerve-system. Huber suggests that the nicotin paralyses not the perikarya of the sympathetic neurons, but rather the end baskets of the pre-ganglionic fibres.

Prof. G. N. Stewart brought forward the results of the application of a new modification of his electrical method of determining speed of blood flow to the question of the output of the mammalian heart. The method depends upon the change of resistance to the passage of electric currents through the blood in an artery or vein brought about by injection of blood serum. Serum conducts better than does entire blood. When the blood admixed with serum reaches the point of blood vessel under examination, electric currents previously balanced by a Wheatstone bridge are thrown out of balance, and it is arranged that a telephone shall announce this event. A specimen of blood is drawn from the corresponding artery in the other limb, and from this is determined the amount of serum which must be added to the normal blood to make its resistance equal to that collected during the passage of the mixture. The output of the heart can, from these data, be determined for the period of injection, and consequently by knowing the pulse-frequency be determined for a single beat. In the dog it is about 2·3 c.c. per second per kilogramme of body-weight.

Prof. Townsend Porter gave an account of observations made upon a strip of the muscle of the apex of the dog's ventricle. The strip is left attached only by a band of pericardium, and yet exhibits in this isolated state rhythmic spontaneous beats. The rhythm of its beat is slow but perfectly regular; it is slower than the rhythm of the rest of the ventricle; it, of course, persisted when the rest of the ventricle was arrested by excitation of the vagus nerve. The blood supply was maintained in the strip by means of an artery and vein in the pericardium. The isolation of the strip from the rest of the myocardium is found, even under microscopical examination, to be absolutely complete. The contractions of the isolated piece could not have been caused by excitation by the action-current accompanying the systole of the rest of the ventricle, as the piece was raised freely in the air. The asynchronism of the beat of the isolated strip and rest of the ventricle prove the same thing, also that the strip was not discharged by nerves accompanying the blood vessels to the strip. Other experiments showed that if an artificial circulation of diluted blood be kept up through the extreme apex of the dog's heart excised and hung up on cannulæ the isolated apex will be vigorously, coordinately, and regularly for several hours. Hence it is concluded that the apex and other parts of the mammalian heart possess spontaneous rhythmic contractility, that the cause of rhythmic contraction is not a single localised coordination centre, the mechanism of coordination, whatever it be, being present in all parts of the ventricle.

Prof. Porter also described experiments confirming MacWilliam's statement that the ventricle of the dog's heart can be recovered from fibrillary contractions. The entire heart of the cat can be readily made to recover even after long-continued and violent fibrillary contraction by free and steady perfusion of fresh blood through the coronary vessels.

When a vein on the surface of the ventricle *in situ* in the living animal is incised and the heart slowed by vagus excitation, the flow from the cut vein is much increased during ventricular contraction. The contraction of the cardiac muscle compresses the veins, and to a less extent the arteries, in the substance of the heart. The systole aids the circulation of blood through the heart muscle. On the other hand, observations with minimum manometers on the veins of the heart give no support to the view that the heart acts on the coronary circulation to any extent as a suction-pump, although efficiently as a force-pump. A circulation through the vessels of Thebesius was demonstrated to be sufficient to keep up the rhythmic beat of the right venticle after the coronary arteries have been closed. Ringer's solution will not maintain the activity of the mammalian heart, but diluted fresh defibrinated blood will.

Prof. Waymouth Reid gave an account of his most recent researches on absorption in the intestine. Heidenhain demonstrated the fact that the water, organic and inorganic solids, of serum introduced into the intestine, are absorbed. The experiment was devised in support of the theory that intestinal absorption is possible under conditions in which osmotic transfer is excluded, and it was found that even inspissated serum is absorbed. Heidenhain omitted to measure the hydrostatic pressure on either side of the intestinal membrane, so that the possibility of the result being due to filtration was not excluded; and, indeed, the ancient filtration theory of Lieberkühn has, with the necessary modern histological modifications, been revived of late by Hamburger. In the experiments now described, the animal's own serum (obtained by the centrifugal machine) was introduced into a loop of its intestine, and the hydrostatic pressure in the cavity of the experimental loop, and in a mesenteric vein proceeding from a control loop, filled with "normal saline" solution, observed continuously during the course of the experiment. Prof. Reid now found that water, organic and inorganic solids, are absorbed against considerable excess of hydrostatic pressure in the blood-vessels. (Since the velocity of the blood-stream in capillaries is low, it is taken for granted that the pressure in the capillaries of the intestinal villi is not lower than that in a mesenteric vein at the border of the gut.) The results of his experiments are practically the same when all the lacteals leaving the experimental loop of intestine have been occluded by ligature.

Prof. Reid called attention to our present inability to explain the phenomena. Great difficulties are offered in the face of the following points, examined and proven by his experiments.

(1) Osmosis, filtration into the blood capillaries, or into the lacteals by the action of Brücke's "villus pump" are, it is considered, excluded by the conditions of the experiment.

(2) That the disappearance of the serum from the cavity of the gut is simply a matter of imbibition is in the highest degree improbable, because the cells must be, at the commencement of the experiment, soaked to the highest degree possible in those constituents of the animal's serum which they are capable of taking up.

(3) Electro-osmotic action is again improbable, because secreting membranes produce ingoing electrical currents as well as absorbing membranes; and, to apply such an hypothesis, it would be necessary to assume that the ingoing current of the cells is active in one case (absorption), the outgoing return current in the other (secretion) involving the further hypothesis of some valvular nature of protoplasm with higher "porosity" in the "in-out" direction in the absorbing, and the "out-in" direction in the secreting, membrane.

(4) Finally, any aspirating action of the blood current in the capillaries of the villi is negligible on account of the low velocity of the current in capillary districts of the circulation.

Prof. W. H. Thompson reported on experiments continued under the committee appointed to examine the effects of peptone and its precursors when introduced into the circulation. The experiments had dealt with the influence of pure peptone, of anti-peptone, and of hetero-albumose on coagulation, on blood-pressure, and on vasomotor irritability. Pure peptone was found to delay but not destroy the coagulability of blood, and to cause a fall in blood-pressure and to lower the vaso-muscular irritability. Antipeptone was found to hasten the coagulation of blood: it causes a very transient fall of arterial blood-pressure, which is immediately followed by a long-continued slight increase of blood-pressure above that present at commencement of the experiment. As to deutero-albumose this substance was not found to give constant results: in some experiments a marked retardation, in others a marked increase of rate of coagulation of blood ensued. It causes a considerable fall in the arterial blood-pressure. Further experiments are in progress on the subject.

Prof. Carl Huber brought forward an important and lengthy paper on the modes of ending of nerve-fibres in smooth, cardiac, and striated muscles. Regarding the last-mentioned it was urged that the nucleated "sole" of the motor end-plate is largely an artefact, derived by expression of the interfibrillar substance of the muscle-fibre The mode of ending of the nerve-fibres in the muscle-spindles shows them, in agreement with Sherrington's experiments, to be sensorial end-organs. The methylene-blue method bears out the description of the ending given by Ruffini, and reveals further details of considerable interest.

Prof. K. Huerthle described a method by which the resistance offered by the vascular channels of an organ to the blood-flow through them may be measured. The viscosity of the blood which, together with the dimensions of the tubular system, form the two factors on which the resistance depends, was determined by allowing the blood from an artery to flow through calibrated capillary tubes for thirty seconds, the quantity, pressure, and duration of flow being accurately measured. The internal friction of the blood of the dog is about 4·5 and of the rabbit 3·2, that of water being unity. If in any particular organ

the quantity of blood flowing through in a unit of time, the arterial pressure, and the coefficient of viscosity be known, it is easy by Poiseuille's law to calculate the bore and length of a tube through which, under given conditions, the same quantity of blood would flow. The aim of the experiments is to measure and express the resistance through the several regions and organs of the body in this manner.

Prof. A. R. Cushny described rhythmic variations in the strength of the contractions of the mammalian ventricle under the action of certain drugs of the digitalis groups. The variations occur only when the ventricle is beating at a rate different from that of the auricle. If the conjunction of the auricular with the ventricular beat fall at a favourable time, the beat of the ventricle is strong; if at an unfavourable, is weak. The systole of the auricles at a certain stage of the rhythm falls at the systole of the ventricle: the auricle in consequence cannot empty itself. It was also pointed out that the action of nicotin on the mammalian heart is exactly similar to its action as discovered by Langley on the ganglia of the sympathetic system.

Prof. Loeb demonstrated experiments on the influence of the discharge of highly-charged conductors on nerve-muscle preparations. It was known that if a highly-charged conductor be discharged in the neighbourhood of a nerve, the muscle contracts. He found in relation to this the following new facts. (1) If the nerve be placed parallel with the spark discharge of a friction machine, maximal effects are obtained when the electrodes are symmetrical in regard to the nerve. If the nerve be set to one side near one electrode the effects decrease. (2) If the nerve be set at right angles with the spark discharge, minimal effects are obtained when the electrodes are symmetrical to the nerve. Strong effects are obtained by placing the nerve near one electrode. (3) By putting a conductor behind the nerve in Case 1, the effects are effaced or diminished. By putting a conductor between the nerve-muscle preparation and one electrode in Case 2, an increase in effect is produced. It had been shown in the last ten years that the phenomena of heliotropism, long observed in plants alone, are common in the animal kingdom. In both cases the effects of the light are determined by the direction of the rays and the length of waves, the more refractive of the visible spectrum being chiefly effective. It is possible to directly stimulate nerve by electric rays. Apparently the galvanic current does not directly act on living matter; its effects as stimulus being in reality only due to the direct or secondary products of electrolysis.

Prof. Waller gave a demonstration and description of the action of various reagents upon the electrotonic currents of nerve. He has succeeded in completely proving that these currents are in the strictest sense physiological, and they therefore become more than ever of high physiological interest. In the frog's nerve the anelectrotonic current considerably exceeds the katelectrotonic in magnitude. The action of acids, of alkalis, of carbonic acid, of some anæsthetics, and also of tetanisation and of variations of temperature were all dealt with in their bearing upon the ratio and magnitude of the electrotonic currents. Slight acidification diminishes the anelectrotonic current and increases the katelectrotonic: treatment with bases diminishes in a typical manner the katelectrotonic current. The effect of prolonged tetanisation upon the katelectrotonic current is similar to that of acidifidation. Its effect, though less uniform on the anelectrotonic current, yet strongly resembles the effect produced by carbonic acid. Prof. Waller, indeed, holds that his experiments bring strong evidence that the tetanisation of nerve induces in the nerve the production of CO_2 to a thus detectible extent. Electrotonic currents are diminished for a time by exhibition of ether vapour, and are rapidly and permanently abolished by weaker percentages of chloroform vapour. In other words, chloroform rapidly kills the nerve outright, while by ether it is easy to merely diminish or abolish the excitability of the nerve for a temporary period.

Dr. Mackay communicated a paper on the absorption of "ferratin" and of hæmoglobin by the intestinal wall. He had used the microchemical tests for iron devised by Prof. Macallum. He found that the iron of ferratin is absorbed by the epithelial cells of the villi, and that it was passed inwards to the leucocytes. Deposits of iron could further be found in the liver, spleen, and lymph glands. The iron of hæmoglobin is absorbed by the epithelial cells as a compound, probably hæmatin. In this case deposits are also found in the organs of the portal system, and there is indication of some excretion of iron in the bile and in the urine.

Dr. Noël Paton read a paper on the phosphorus metabolism of the salmon in fresh water. Sample salmon were throughout the spring, summer and autumn taken from the mouths of certain rivers, and others from the upper waters of the same rivers. Abundant observations clearly show that the fish do not feed during their stay in fresh water. The muscle substance steadily diminishes, while the ovaries and testes grow at its expense. The fats and proteids lost from the muscles are sufficient to supply these materials for the growing genitalia, and to yield a very large amount of energy for muscular work. The question here discussed is the exchange of phosphorus. It is first shown that in muscle the phosphorus is chiefly in the form of inorganic phosphates, though a comparatively large amount of lecithin and a small amount of nuclein are also present. In the ovary the phosphorus is chiefly combined in the pseudo-nuclein—ichthulin; but it is also present in considerable amounts in lecithin, and in very small amounts as inorganic phosphates. In the testis the phosphorus is chiefly in the form of true nucleins, but there are also a considerable quantity of lecithin and a small quantity of inorganic phosphate. As the season advances the phosphorus in the genitalia increases, while the phosphorus of the muscle diminishes. The loss of phosphorus from the muscle is barely sufficient to account for the gain in the ovary, amply sufficient to yield the increase of phosphorus in the testis. The lecithin lost from the muscle is sufficient only to account for a small part of the lecithin gained by the ovary. The lecithin and ichthulin of the ovary must thus be found by synthesis as these structures grow. The nuclein of the testis must be formed in a similar manner.

The presence of considerable amounts of lecithin in the growing ovary and testis would seem to indicate that this substance is one of the first stages in the construction of nucleo compounds.

Prof. W. P. Lombard gave a communication on the effect of frequent excitations on the contractility of striped muscle. When the muscle is made to give a series of contractions the height of the contraction is seen to increase. The muscle contracted very much higher to an induction shock just after than just before a short period of tetanic excitations. Each of a series of short tetani following each other in rapid succession was, until fatigue appeared, higher than its predecessor. The after effect of excitation is to increase the capacity of the muscle to shorten. When the inertia of the writing lever is increased each of a series of short tetani is seen to begin with a sudden high rise, the throw of the lever carrying the curve above the actual shortening of the muscle. The height of the introductory peak exhibits in repeated tetani a staircase-like growth, and this, in spite of the total contraction being lessened by an increasing growth of contracture heightening the base-line. The effect of the repeated excitations is to cause a more and more sudden and intense liberation of energy.

Prof. Sherrington demonstrated the production of an intense colour of subjective origin by whirling a disc coloured with red on a black-white ground. The disc should contain a black sector of about 170°. From one edge of the black sector broad concentric vermilion arcs are carried into the peripheral white part of the discs for about 90°; from the other edge of the disc similar arcs in the central part of the white field. On rotating the disc so that black follows red in the circumferential field, and precedes red in the central, the outer arcs appear a dull dark maroon, the inner a bright orange, and the spaces between the outer arcs appear deep blue-green, and the spaces between the inner arcs appear primrose-yellow, especially when viewed by a yellowish illumination. Prof. Sherrington offered an explanation for the phenomenon which he based on negative after-images heightened by simultaneous and successive contrast-effects which, as he demonstrated at the meeting. take effect even when speed of translation of a surface prevents the mind from perceiving the space-relations of the distribution of the contrasted tints. It was pointed out that the disc is being used in this experiment similarly to a circular rheotome for summation of effects which taken singly would by reason of their small quantity be imperceptible. It was also demonstrated that by whirling the disc at higher speed the phenomenon becomes altered, the reds and greys then matching over the whole surface of the disc, the greys assuming a pale green tint; when this is obtained, it was urged that one factor

of those previously acting, namely simultaneous contrast, had alone become valent.

Prof. Halliburton and Dr. Mott made a communication on the effects produced on the arterial blood-pressure by the intravenous injection of choline, neurine, and allied substances. Normal cerebro-spinal fluid produced no effect, while that obtained *post-mortem* from cases of general paralysis of the insane produced a fall of blood-pressure. This is not due to a proteid body present; for after coagulation by boiling, or precipitation by alcohol, a similar effect is produced. Neurine hydrochloride in 0·1 per cent. solution gave a similar fall, but in most cases this was followed by a rise and then by a more persistent fall of blood pressure. Choline hydrochloride in 0·2 per cent. solution gave results identical with those obtained by the pathological cerebro-spinal fluids. Blood taken from patients suffering from pseudo-apoplectiform convulsions of general paralysis was precipitated with alcohol, and the filtrate, after evaporation to dryness and solution in saline, injected, and the effect produced corresponded entirely with that obtained with pathological cerebro-spinal fluids and with solution of choline. Normal blood gave a negative result. The fall of blood-pressure produced by these various reagents is cardiac in origin. This was established by plethysmographic tracings and by experiments on the frog's and mammal's heart. This agrees very well with what is found in general paralysis, cardiac weakness, and enfeebled circulation.

Prof. Richet related experiments by which he had succeeded in showing and measuring in the dog the refractory period of the bulbar and cerebral nervous centres. The animal is cooled down to 30° C. and anæsthetised. It will then react to electrical stimulations of the cortex if the stimulations be not too frequent. If the rhythm of these be 1 per second, the responses are equal in magnitude; if 4 per second, there will be one large and then one small response; if 10 per second, there will be no longer a response to each excitation but one to each alternate. Half of the stimuli fall within a refractory period. The duration of the refractory period is 1/10″. It is possible to show that, as was originally indicated by the experiments of V. Kries, volitional impulses have a frequency of repetition of about 10 or 11 in a second.

Dr. F. S. Lee brought forward the results of his continued researches into the functions of the semicircular canals in fishes, especially in regard to maintenance of equilibrium and to locomotion.

Prof. Anderson Stuart made an interesting communication on the canal of Stilling. He also showed models illustrating the horopter.

Mr. O. Grunbaum contributed a communication upon the effects of intermittent retinal stimulation. He exhibited the results of several series of experiments stated in curves with measures of speed of alternation as ordinate-heights and degrees of illumination as abscissæ. The curves so obtained possess each an apex above, denoting that a sensation of continuous stimulation results if the luminosity be below or beyond a certain amount. The curve begins to descend some distance prior to the use of a degree of luminosity such as to produce a blinding after-image.

Dr. A. Grunbaum gave a communication on muscle spindles found in human muscles; the communication was illustrated by microphotograms.

Profs. Boyce and Herdman contributed the results of their investigations on "green oysters." They had demonstrated copper in comparatively large quantity in the green leucocytes of the American oyster. The green colour in these oysters is in direct proportion to the copper present. The copper indicates a pathological condition of these American oysters. They were not prepared to state whether copper in the food of the oyster can bring about the condition, but there is abundant evidence to show that it can occur where no copper mines or other evident sources of copper are present. The normal copper of the hæmocyanin of the blood, which is probably constantly circulating through the body in minute quantity, may cease to be removed, and so become stored in certain cells in the oyster. The deposition of the copper in the large quantity found appeared to them the result of a degenerative process.

Prof. Boyce communicated a paper by Dr. Warrington (Liverpool). The effects of ischœmia on the structural features of nerve-cells were shown to be very marked. Also the effect of cutting off from the anterior coronal cells the afferent impulses usually impinging on them was studied in cases where the posterior roots had been divided. Marked changes were found, which were minutely described. On the other hand, attempts to discover changes in the cells of the oculomitorius and facialis nuclei after section of their nerve-trunks failed to detect any changes.

In experiments of the kind mentioned above, in which changes uniformly resulted, the typical picture of alteration is very characteristic; the cell becomes somewhat enlarged, is stained red, with a small amount of blue chromophitic granules at its periphery, the nucleus remaining well-marked. The changes go on to a further swelling up of the cell, a disappearance of its nucleus, and finally shrinkage and ultimate disappearance. The paper was illustrated by microphotographs. The method of staining of the preparations employed had been the methylene-blue and erythrosin modification of Nissl's stain.

Prof. Macallum made a long and important communication on the structures of the nucleus and body of the cell, and described the views at which he had arrived on this profound and difficult subject.

Prof. Wesley Mills contributed interesting papers on the psychic development of young animals, on the functional development of the cerebral cortex, and on cortical cerebral localisation.

Miss F. Welby contributed an interesting account of observations on the effect of curvesthetic vapours on the cardiac muscle of the frog; her remarks being illustrated by the projection of the graphic records of the experiments.

The morning of Tuesday, August 24, was devoted to a combined meeting of the sections Physiology and Botany to discuss the chemistry and structure of the cell. Several members of the section of Chemistry also took part, the opening paper being by Prof. Meldola. Profs. Marshall Ward, Armstrong, Green, Macallum, Remsen, Farmer, and Halliburton, spoke in the discussion.

Prof. Meldola devoted his opening paper to a discussion of the *rationale* of chemical synthesis of bodies formed by living organisms.

The presidential address by Prof. Foster was given in the large Zoology Theatre of the University; it was very numerously attended. It was a retrospect of the history of physiology since the previous meeting of the British Association at Montreal in 1884. It was pointed out that the opportunities for studying physiology had grown larger and more facile. "But there is still a larger outcome from the professional chair and physiological laboratory than the training of students. Each post for teaching is no less a post for learning. Among academic duties the making of knowledge is no less a duty than the distributing of it." "Practical expression has been given to this feeling more vigorously in Canada and the United States than in the old country." "Physiology is destined, in consequence of its containing the study of the actions of the brain, to modify the attitude of the physiologist toward the world, and of the world toward the physiologlst. That physiology is, and must always be the basis of the art of healing is a truism, but if a plebiscite limited to instructed, one might almost say scientific, men were taken at the present moment, it would probably enough be found that the most prevalent conception of physiology is that it is something which is in some way an appendage to the art of medicine." But without plunging "into the deep waters of the relation which body bears to mind, this at least stares us in the face that changes in what we call the body bring about changes in what we call the mind. When we alter the one we alter the other. . . . If, as the whole past history of our science leads us to expect, in the coming years a clearer and clearer insight into the nature and conditions of that molecular dance which is to us the material token of nervous action, and a fuller exacter knowledge of the laws which govern the sweep of nervous impulses along fibre and cell, give us wider and directer command over the moulding of the growing nervous mechanism and the maintenance and regulation of the grown one, then assuredly physiology will take its place as a judge of appeal in questions not only of the body, but of the mind; it will raise its voice, not in the hospital and consulting room only, but also in the senate and the school."

ON THE SUMMIT OF MAUNA LOA.

DR. H. B. GUPPY has contributed to the *Pacific Commercial Advertiser*, published at Honolulu, an account of observations made during a three weeks' sojourn upon the summit of Mauna Loa in August last.

The air at first was highly electrified. A red blanket used

by Dr. Guppy crackled under his hands at night, and he could trace letters on its surface in phosphorescent hues with his finger-nail as he lay completely enveloped in its folds. The effects of these meteorological conditions soon showed themselves in the cessation of the action of the skin, in severe headaches and sore-throat; in a tendency to palpitation and dyspnœa, and in sleeplessness, general lassitude and loss of appetite, most of which symptoms were attributed to the great lack of moisture in the air, for when a short spell of damp weather intervened, most of the unpleasant symptoms disappeared. An interesting phenomenon was observed every morning and evening. For about twenty minutes after sunrise and before sunset the shadow of the mountain was thrown back against the sky of the opposite horizon. It seemed as if some artist had been at work on the sky far away, and had painted in the profile of the mountain with a very uncanny blue.

Dr. Guppy's observations on the relative humidity have yet to be worked out, but he remarks that there was occasionally as much as a difference of 20° between the wet and dry bulb thermometers, the usual difference being 10° to 15°. The lowest temperature recorded at night was 15° F., and the minimum reading was usually below 20°. The average minimum temperature for the period, August 9 to 31, was 23°·5. The highest temperature of the air in the shade was 61°·2, the average maximum daily being 53° 6, which places the average difference between the night and day temperature at 30°. This great daily range is about twice what it is at the coast.

State of the Crater.

In order to familiarise himself with the principal features of the crater, Dr. Guppy adopted the method of making a rough plan of it with a pocket prismatic compass. In some places the lava crust was thin and fragile, and although he never descended further than his waist, there was always in such localities a chance of a sudden descent into a cavern of considerable depth.

His descent into the crater was made on the north-west side. It was a tedious operation, and the loose boulders had to be trodden on very carefully, as they are often inclined to roll down and crush the intruder. As soon as Dr. Guppy reached near the centre of the great pit the clouds began to pour in on all sides over the lips of the crater. In a few minutes he was enveloped in a dense mist, and any further observation was rendered impracticable. During the prevailing dry clear weather with a cloudless sky, "smoke" is only evident in two places in the crater, one near the centre and the other in the south-west corner from the base of a yellowish cliff, where there are apparently extensive deposits of sulphur. When, however, the sky is clouded, and especially when the air is moist, white vapour may be seen arising from the greater part of the surface of the crater. The change is a little startling, the true explanation being that a large amount of the vapour evolved is only visible in cloudy murky weather. It is, therefore, possible that the accounts of two observers may vary greatly as to the crater's condition, and yet no difference in the condition actually exist. This especially applies to the district on the south and south-west borders of the crater, stretching about a mile to the southward. In cloudy weather white vapour arises from many places in this area. In the bright clear weather that prevails the visitor may see nothing, and even walk unwittingly over numerous cracks and fissures whence the invisible vapour is being discharged. Dr. Guppy took the temperature of several of these fissures. In those where the vapour was only seen in cloudy weather the temperature was about 104° F. When the "smoke" is always visible the temperature is far higher, 160° F. and over. Many of these cracks and fissures exhibit evidence of having originally given passage to vapours at a very high temperature. The subterranean heat appears now more actively displayed in the district extending a mile to the south of the big crater than in the crater itself. A very large amount of vapour is discharged from the borders of a small crater lying near Pohaku Hanalei, and this is probably the smoke sometimes observed from the Kona coast. It is probable that the next eruption will occur on this, the south south-west slope of the mountain.

Insect Life on the Summit.

Curiously enough, insects of various descriptions are common on the summit. One species of butterfly common at the coast is not at all infrequent. The butterflies were more often to be found dead than alive, and those flying about were in a half-drowsy condition and easily caught. There were flies of different kinds, the house-fly and the blue-bottle-fly proving a great nuisance. Besides these there were moths, bees, gnats, and an occasional dead dragon-fly; whilst bugs and other insects were collected as they fed upon the bodies of the dead butterflies. These insects were more common when the wind was southerly, and no doubt they had been brought up to this absolutely sterile region by the wind. Evidently most if not all of the butterflies and moths soon die, and probably the other insects too. The whole matter is, however, very suggestive, and shows how readily insects (even the parasitical bug) may find their way into the upper air-currents.

PALESTINE EXPLORATION.[1]

THE object of exploration is to obtain accurate knowledge of a country, its inhabitants, and its extant monuments and texts. That of Palestine has special interest to Christian races and to Jews, as serving to explain more clearly the sacred literature of their faith.

The results of such exploration may be judged by looking back a century to the time of Bayle, Voltaire and Astruc, when what was regarded as advanced scientific work assumed that the Hebrews were a savage race without literature, that history only began to be written about 500 B.C., and that the oldest civilisation was that of China and India. It is now known that the art of writing was practised in Egypt and Chaldea as early as 3000 B.C., that the Canaanites about the time of Joshua had a civilisation equal to that of surrounding nations, as had also the Hebrew kings; while, on the other hand, Chinese civilisation is only traceable to about 800 B C., and that of India was derived from the later Persians, Arabs and Greeks. These results are due solely to exploration.

The requirements for exploration demand a knowledge not only of Syrian antiquities but of those of neighbouring nations. It is necessary to understand the scripts and languages in use, and to study the original records as well as the art and architecture of various ages and countries. Much of our information is derived from Egyptian and Assyrian records of conquest, as well as from the monuments of Palestine itself. As regards *scripts*, the earliest alphabetic texts date only from about 900 B.C., but previous to this period we have to deal with the cuneiform, the Egyptian, the Hittite and the Cypriote characters. The explorer must know the history of the cuneiform from 2700 B C. down to the Greek and Roman age, and the changes which occurred in the forms of some 550 characters originally hieroglyphics, but finally reduced to a rude alphabet by the Persians, and used not only in Babylonia and Assyria but also as early as 1500 B.C. in Asia Minor, Syria, Armenia, Palestine, and even by special scribes in Egypt. He should also be able to read the various Egyptian scripts—the 400 hieroglyphics of the monuments, the hieratic, or running hand of the papyri, and the later demotic. The Hittite characters are quite distinct, and number at least 130 characters, used in Syria and Asia Minor from 1500 B.C., or earlier, down to about 700 B.C. The study of these characters is in its infancy. The syllabary of Cyprus was a character derived from these Hittite hieroglyphics, and used by the Greeks about 300 B.C. It includes some fifty characters, and was probably the original system whence the Phœnician alphabet was derived. As regards alphabets, the explorer must study the early Phœnician, and the Hebrew, Samaritan and Moabite, with the later Aramean branch of this alphabet, whence square Hebrew is derived. He must also know the Ionian alphabet, whence Greek and Roman characters arose, and the early Arab scripts—Palmyrene, Nabathean and Sabean, whence are derived the Syriac, Cufic, Arabic and Himyaritic alphabets.

As regards *languages*, the scholars of the last century had to deal only with Hebrew, Aramaic, Syriac, Coptic and Greek, but as the result of exploration we now deal with the Ancient Egyptian whence Coptic is derived, and with various languages in cuneiform script, including the Akkadian (resembling pure Turkish) and the allied dialects of Susa, Media, Armenia and of the Hittites; the Assyrian, the earliest and most elaborate of Semitic languages; and Aryan tongues, such as the Persian, the Vannic and the Lycian.

The *art and architecture* of Western Asia also furnishes much information as to religious ideas, customs, dress and history, including inscribed seals and amulets, early coins and gems. The explorer must also study the remains of Greek, Roman, Arab and Crusader periods, in order to distinguish these from the earlier remains of the Canaanites, Phœnicians, Hebrews,

[1] A discourse at the Royal Institution by Lieut. Colonel C. R. Conder.

Egyptians and Assyrians, as well as the art of the Jews and Gnostics about the Christian era, and the later pagan structures down to the fourth century A.D.

The monuments actually found in Palestine are few though important. The discovery at Tell el Amarna of about 150 letters written by Phœnicians, Philistines and Amorites—and in one case by a Hittite prince—to the kings of Egypt, proves, however, the use of cuneiform on clay tablets by the Syrians as early as 1500 B.C., and one such letter has been recovered in the ruins of Lachish. The oldest monuments referring to Syria and Palestine are found at *Tell Loh*, on the Lower Euphrates, and date from 2700 B.C. Next to these are the *Karnak* lists of Thothmes III. about 1600 B.C., recording the names of 119 towns in Palestine conquered after the defeat of the Hittites at Megiddo These lists show that the town names which occur in the Bible are mainly Canaanite and were not of Hebrew origin. The Canaanite language of this period was practically the same as the Assyrian, excepting that of the Hittites, which was akin to the Akkadian. In the next century the Tell el Amarna tablets show that the Canaanites had walled cities, temples, chariots, and a fully developed native art. They record the defeat of the Egyptians in the north by Hittites and Amorites, and the invasion of the south by the Abiri, in whom Drs. Zimmern and Winckler recognise the Hebrews, the period coinciding with the Old Testament date for Joshua's conquest.

An inscription of Mineptah, discovered in 1896, speaks of the Israelites as already inhabiting Palestine about 1300 B.C., and agrees with the preceding. Other Egyptian records refer to the conquests of Rameses II. in Galilee and in Syria, when the Hittites retained their independence; and in the time of Rehoboam, Shishak has left a list of his conquests of 133 towns in Palestine, including the names of many towns noticed in the Bible.

The Hittite texts found at Hamath, Carchemish and Merash, as well as in Asia Minor, belonged to temples, and accompany sculptures of religious origin. They are still imperfectly understood, but the character of the languages, the Mongol origin of the people, and the equality of their civilisation to that of their neighbours, have been established, while their history is recovered from Egyptian and Assyrian notices. The Amorites were a Semitic people akin to the Assyrians, and their language and civilisation are known from their own records, while they are represented at Karnak with Semitic features.

The oldest alphabetic text is that of the Moabite stone about 900 B.C. found at Dibon, east of the Dead Sea, on a pillar of basalt, and recording the victories of King Mesha over the Hebrews, as mentioned in the Bible. Several Bible towns are noticed, with the name of King Omri, and the language, though approaching Hebrew very closely, gives us a Moabite dialect akin to the Syrian, which is preserved in texts at Samalla, in the extreme north of Syria, dating from 800 B.C. The Phœnician inscriptions found at Jaffa, Acre, Tyre, Sidon, Gebal and in Cyprus do not date earlier than 600 B.C., and show us a distinct dialect less like Hebrew than the Moabite. The most important of these early texts is the Siloam inscription in the rock-cut aqueduct above the pool, found by a Jewish boy in 1880. It refers only to the cutting of the aqueduct (in the time of Hezekiah), but it gives us the alphabet of the Hebrews and a language the same as that of Isaiah's contemporary writings. It is the only true Hebrew record yet found on monuments, and confirms the Old Testament account of Hezekiah's work.

The Assyrian records refer to the capture of Damascus by Tiglath Pileser III. in 732 B.C., and of Samaria in 722 B.C., as well as to Sennacherib's attack on Jerusalem in 702 B.C. The latter record witnesses also the civilisation of the Hebrews under Hezekiah, whose name occurs as well as those of Jehu, Azariah, Menahem, Ahaz, Pekah, and Hosea, who, with Manasseh, gave tribute to Assyrian kings.

About the Christian era Greek texts occur in Palestine, the most important being that of Herod's Temple at Jerusalem, forbidding strangers to enter, and those of Siah in Bashan, where also Herod erected a temple to a pagan deity. Such texts are very numerous in Decapolis, where a Greek population appears to have settled in the time of Christ.

The geographical results of exploration are also important for critical purposes. Out of about 500 towns in Palestine noticed in the Old Testament, 400 retain their ancient names, and about 150 of these were unknown before the survey of the country in 1872-82. The result of these discoveries has been to show that the topography of the Bible is accurate, and that the writers must have had an intimate knowledge of the land. Among the most interesting Old Testament sites may be mentioned Lachish, Debir, Megiddo, Mahanaim, Gezer, and Adullam as newly identified; and of New Testament sites, Bethabara, Ænon, and Sychar, all noticed in the fourth Gospel.

The existing Hebrew remains are few as compared with Roman, Arab, and Norman ruins of later ages. They include tombs, aqueducts, and fortress walls, with seals, weights, and coins. The most important are the walls of the outer court of Herod's great temple at Jerusalem, with his palace at Herodium, and buildings at Cæsarea and Samaria. The curious semi-Greek palace of Hyrcanus at Tyrus in Gilead dates from 176 B.C. In Upper Galilee and east of Jordan there are many rude stone monuments—dolmens and standing stones—probably of Canaanite origin, as are the small bronze and pottery idols found in the ruins of Lachish. Sculptured bas-reliefs are, however, not found in Palestine proper, having been probably destroyed by the Hebrews.

This slight sketch may suffice to show the advance in knowledge due to exploration during the last thirty years. The result has been a great change in educated opinion as to the antiquity of civilisation among the Hebrews and Jews, and as to the historic reliability of the Bible records. Further exploration, especially by excavation, may be expected to produce yet more interesting results, and deserves general support, as all classes of thinkers agree in the desirability of increasing actual knowledge of the past. It is no longer possible to regard the Hebrews as an ignorant and savage people, or to consider their sacred writings as belonging necessarily to the later times of subjection under the Persians. Internal criticism is checked and controlled by the results of exploration, and by the recovery of independent historical notices.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Walsingham Medal, given by the Lord High Steward, for original research in botany, geology, zoology, or physiology, is open to all graduates of the University under the standing of M.A. Monographs for the ensuing year are to be sent to Prof. Newton, Magdalene College, by October 10, 1898.

An examination for the Sheepshanks Astronomical Exhibition will be held in Trinity College on November 19 and 20. In addition to papers on astronomy, there will be an oral and practical examination at the Observatory. Candidates must be undergraduates, and, if successful, must become members of Trinity College.

Mr. G. H. A. Wilson, fifth wrangler 1895, has been elected to a fellowship at Clare College.

PROF. JAMES M. CRAFTS, professor of organic chemistry in the Massachusetts Institute of Technology, will succeed the late General Francis A. Walker as the president of the Institute.

THE *London Technical Education Gazette* announces that a course on practical chemistry, dealing with the "manipulation of gases," will be conducted by Mr. M. W. Travers, at University College, on Fridays, at 5.30 p.m., commencing on Friday, November 12. This course will be of great value to those engaged in gas testing, and will deal with methods not hitherto published. A research course for teachers on "The effect of repeated heating on the magnetic permeability and electrical conductivity of iron and steel," is being conducted by Principal Tomlinson, F.R.S., at the South-west London Polytechnic, Manresa Road, Chelsea, on Saturday mornings from 10 to 1, with facilities for continuing experiments, if desired, from 2 to 5. Teachers are admitted free; there are still a few vacant places in the class. Any teachers who wish to join should apply at once to Principal Tomlinson.

THE first volume of the Report of the United States Commissioner of Education, for the year 1895–96, has been received. Though largely concerned with elementary schools, the report contains several noteworthy articles on the higher branches of education. A detailed account is given of the Education Bill of 1896, and the discussions which led to its withdrawal. Current statistics of education in Great Britain form the subject of a special chapter. Some of the features of the educational systems of Germany, Austria, and Switzerland are reported upon, the statistics which the report gives as to higher education in the German-speaking part of Europe being very valuable. It appears from the extensive tables contained in the

report that there are 75 higher seats of learning in Germany, Austria proper, and Switzerland, having altogether 5963 professors, 67,062 students, and 6628 foreign students. There is in Germany one professor for 12·1 students, and an average of 78·4 professors and 926·3 students (of whom 67·2 are foreigners) to one seat of learning. Austria has one professor for 11·7 students, and an average of 80·5 professors and 949·4 students (of whom 91·1 are foreigners) to one higher seat of learning. Switzerland has one professor for 5·9 students, and an average of 96·2 professors and 569·6 students (of whom 208·3 are foreigners) to one higher seat of learning. Among other subjects of articles in the report are: the comparative study of popular education among civilised nations; education in France; education in Mexico and Central America; commercial education in Europe, particularly in Austria, France, and Germany; and the correlation of studies.

ONE of the most gratifying signs of educational progress is the increasing efficiency of technical institutions in the provinces as well as in London. These schools are not only far better equipped than they were a few years ago, but in many cases the members of the teaching staffs are better qualified to impart instruction. The prospectuses and calendars which come before us from time to time testify to a real development of facilities for education in science and technology, and we are glad to observe the advances which technical schools are making all over the country. A prospectus just received from the Technical College, Huddersfield, furnishes an instance of valuable work being done in a large technical college outside London. This college provides full courses, both theoretical and practical, and of an advanced type, in physics, chemistry, biology, art, engineering, weaving and dyeing. There are also separate departments for mathematics, languages ancient and modern, and commercial subjects; whilst a mining section is in process of formation. Of especial importance is the fact that the college library consists of some 10,000 volumes, an annual sum of 160*l.* being devoted towards the purchase and binding of books, periodicals, &c. At the present time an extension, calculated to cost about 13,000*l.*, is being carried out. Improved accommodation will thus be provided for chemistry and physics, and engineering; a room 105 feet by 27 feet has also been set aside for a museum for biology and mineralogy. The number of students of both sexes for the last two or three years averages about twelve hundred. Students can at present take up at the college all the subjects required by the London University for a degree in art or science, and they will be able to continue to their D.Sc. work when the new chemical and physical laboratories are completed. In all departments we notice that practical work is carried on as well as lectures. Dr. S. G. Rawson, the principal, appears to be developing the college on the right lines, and Huddersfield will doubtless benefit by the work he is doing. Financially the college is also in a satisfactory condition. We think both council and staff are to be congratulated upon the care and energy which has been displayed in building up so strong and useful an institution.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, October 29.—Mr. Shelford Bidwell, President, in the chair.—Prof. Stroud exhibited and described the Barr and Stroud "range-finder." The problem of finding the distance of a given object at sea, or in the field, is complicated by shortness of the trigonometrical "base," and by restrictions of time. As a rule, the apparatus must be self-contained, and "snap-shot" readings are obligatory, *i.e.* the range has to be determined from a single instrument and from a single observation. At 3000 yards the errors must not exceed 3 per cent. In foggy weather, or when viewing a nebulous object, this degree of precision is difficult to attain, but under favourable circumstances the authors have determined ranges, at that distance, within 1 per cent. of accuracy. At shorter ranges measurement is more exact; thus an object at about 2000 yards may be estimated to within about 12 yards. Prof. Stroud gave some account of the history and of the general methods employed in these instruments. Two images of the distant object, preferably of a line such as a flag-staff, are received respectively upon two mirrors, two lenses, or two prisms, placed one at each end of a fixed support. From each of these, the light is then directed towards the middle of the instrument, where the two images, after further reflection, are viewed by one eye-piece. The optical system has finally to be adjusted so that the two images, as now seen in the eye-piece, lie in the same straight line. In the instrument designed by the authors this coincidence is attained by translating a small prism parallel to the axis of the supporting rod. The extent of this translation is a measure of the range. Both eyes are used: the right for bringing the two images into alignment; the left for "finding" the object through a small field-glass, and for reading the scale of distances. At night, sightings have to be taken from "points" of light, and as these are unsuited for measurement, the authors convert them into "lines" by the use of cylindrical lenses. Various devices are introduced to prevent overlapping of the images. The instrument is about five feet long, and tubular in form; it is made of copper, so as to have high thermal conductivity to reduce differential heating. Within the outer tube is the interior supporting rod, designed to equalise so far as possible the effects of interior radiations. Several forms of "separating" prisms were exhibited, the best for the purpose consists of two "reflecting" prisms; these receive the two rays and direct both of them into a third prism, whose angle lies in the space between the angles of the others. Mr. Barr drew attention to the gimbal arrangement and the three struts that keep the supporting rod centred in the tube. To give some idea of the precision and scope of the range-finder, he observed that they were there using the equivalent of a 25-feet "circle," and their measurements were comparable to the measurement of 20 secs. of angle on such a circle. The instrument is handled by ordinary seamen, and stands rough usage on board ship for years without injury.—Prof. Stroud then exhibited "a folometer and spherometer." He explained that in determining curvatures and focal lengths, some telemetric method was necessary, and that, owing to want of parallelism of the beam, and duplication of images, a short-focus telescope was always an inefficient telemeter. For the measurement of inaccessible lengths it was therefore better to use some simple form of "range-finder." Such an apparatus could be made with a set of small mirrors arranged in such a manner as to direct two images of the distant object into an eye-piece, with a fixed prism in the path of one of the incident beams. By sliding this instrument along the optical bench one position could always be found at which the two images, as seen through the eye-piece, were in coincidence. He also described a method for determining curvature by interposing a plate of plane glass between the curved mirror and a source of light.—Mr. Ackermann exhibited two experiments. (1) The blowing-out of a candle-flame by the air from a deflating soap-bubble. The bubble was blown at the mouth of an inverted beaker by breathing into a hole cut out at the top. This hole was then presented to the flame, and the flame was immediately quenched. But if the bubble was blown from ordinary air, with bellows, the flame was merely deflected without being extinguished. (2) It was shown that a miniature boat, provided with a false stern, consisting of a linen diaphragm, could be propelled by filling the hollow stern-space with ether, or with some liquid similarly miscible with water. The motion is due to the continuous release of surface-tension behind the boat. Prof. Boys said that when he tried, some years ago, to blow out a candle with a soap-bubble filled with common air, he found the operation very difficult—so difficult that, having once succeeded, he never repeated the attempt. It had not occurred to him, as it had to Mr. Ackermann, that the CO_2 present in the breath played a part in the quenching. With regard to the second experiment, he had seen a small boat propelled by dissolving camphor astern, but he thought the use of a liquid for that purpose was a novelty.—The President proposed votes of thanks, and the meeting was adjourned until November 12.

PARIS.

Academy of Sciences, October 26.—M. A. Chatin in the chair.—Apparatus for measuring the altitudes attained by balloons. Verification of the results furnished by barometers, by M. L. Cailletet. The dial of the aneroid is placed exactly in the focus of a photographic camera, to which such a mechanism is fitted that every two minutes two photographs are taken simultaneously, one of the barometer and another of the earth. From the focal length of the photographic objective, the distance of any two points on the earth, and the distance of these two points on the negative, the calculation of the true height is easily calculated. The apparatus worked perfectly in a preliminary balloon ascent made by MM. Hermite and Besançon.—Report on a memoir of M. Hadamard, entitled

"On the geodesic lines of surfaces of opposite curvatures," by M. H. Poincaré.—Observations on the new Perrine comet (1897, October 16), made at the Observatory of Paris, by M. G. Bigourdan.—Observations of the same comet made at the Observatory of Toulouse, by M. F. Rossard.—On the deformation of quadrics, by M. C. Guichard.—On systems completely orthogonal in space of n dimensions, and on the reduction of more general differential systems, by M. Jules Drach.—On Weingarten surfaces, by M. A. Pellet.—On a new method of reducing the time of exposure in radiography, by M. Gaston Séguy. A thin glass plate is coated on both sides with an emulsion of gelatino-silver bromide, and allowed to dry. This is then enclosed between two flexible screens, formed by M. Becquerel's calcium violet in suspension in celluloid, and the whole pressed together between cards. A photograph of the thorax, using a six-inch coil, with thirty seconds' exposure, was completely satisfactory, every detail being shown with great clearness.—On a new bianodic bulb, with a red phosphorescence. The glass of the bulb is tinged with didymium chloride. The fluorescence is red instead of green, giving twice as much of the X-rays as ordinary glass. The effects on the screen are very brilliant, and can be seen by persons colour-blind to green.—Researches on saline solutions; lithium chloride, by M. Georges Lemoine. Thermal data, showing the heat of dilution of solutions of lithium chloride in water, methyl and ethyl alcohols.—On some basic salts of magnesium, by M. Tassilly. The preparation and properties of the oxybromide $MgBr_2.3MgO.12H_2O$ is described. — The separation and direct estimation of chlorine and bromine in a mixture of alkaline salts, by MM. H. Baubigny and P. Rivals. The separation is effected by potassium permanganate in presence of a large excess of copper sulphate. Analytical results are given, showing the trustworthiness of the method under varying conditions.—On some combinations of metallic acetates with phenylhydrazine, by M. J. Moitessier. Double salts are formed with phenylhydrazine by the acetates of zinc, cadmium, manganese, cobalt, and nickel.—The methods of estimating diabetic sugar, by M. Fréderic Landolph. A comparison of the results obtained in the estimation of diabetic sugar by the polariscopic, fermentation, and copper reduction methods, showed that only the optical can be depended upon.—Optical and reducing power of the flesh of flies, by the same.—Action of the X-rays upon the cutaneous evaporation, by M. L. Lecercle. In the rabbit, the evaporation of a given portion of the skin can be almost completely suppressed, and the effects continue for some time after the exposure. On the human hand, evaporation is somewhat checked, but the action is fugitive, and the evaporation rapidly recovers its original value.—On yellow fever, by M. le Dr. Domingos Freire. A description of the habits and mode of growth of the bacillus, *Micrococcus xanthogenicus* Attenuated cultures of this bacillus, injected into animals and man, produce a mild form of yellow fever, which confers immunity from the disease. Since 1883 some 13,000 persons have been inoculated, of all ages and nationalities. The subsequent mortality from yellow fever, in spite of violent epidemics which have raged, has not exceeded six per thousand.—Observations on the circulation of the Amphictenia, by M. Pierre Fauvel.—On the differentiation and development of the woody elements, by M. L Jules Léger. The discovery of a Miocene bat at Grive-Saint-Alban, by M. Claude Gaillard. A complete humerus, and some fragments were discovered.—On the Armand cave, by MM. E. A. Martel and A. Viré. A description of the results of the exploration of a subterranean cave, 207 metres deep, the most remarkable feature being a forest of two hundred stalagmitic columns, of heights varying between three and thirty metres.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 4.

LINNEAN SOCIETY, at 8.—The Attraction of Flowers for Insects: Sir John Lubbock, Bart.—Transfusion-Tissue: its Origin and Function in the Leaves of Gymnospermous Plants: W. C. Worsdell.

CHEMICAL SOCIETY, at 8.—The Properties of Liquid Fluorine: Profs. Moissan and Dewar.—The Liquefaction of Air and the Detection of Impurities: Prof. Dewar.—The Absorption of Hydrogen by Palladium at High Temperatures and Pressures: Prof. Dewar.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Mechanical Features of Electric Traction: Philip Dawson.

FRIDAY, NOVEMBER 5.

RÖNTGEN SOCIETY, at 8.—Address by Prof. S. P. Thompson.

MONDAY, NOVEMBER 8.

ROYAL GEOGRAPHICAL SOCIETY (Queen's Hall, Langham Place), at 8.45.—Introductory Address by the President.—The Jackson-Harmsworth Arctic Expedition: Frederick G. Jackson.

TUESDAY, NOVEMBER 9.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Manchester Ship Canal; Sir E. Leader Williams.—The Mersey Estuary Embankments—Eastham Division: Whately Eliot.—The Mersey Estuary Embankments and other Works—Runcorn Division: Sir E. Leader Williams.—The Irlam Division: W. O. E. Meade-King.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Works of Art from Benin City C. H. Read and O. M. Dalton.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Spectroscope: E. W. Maunder.

THURSDAY, NOVEMBER 11.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Accumulator Traction on Rails and Ordinary Roads: L. Epstein.

MATHEMATICAL SOCIETY, at 8.—On the Poncelet Polygons of a Limaçon: Prof. F. Morley.—On an Extension of the Exponential Theorem: J. E. Campbell.—The Integral $\int P_n^2\,dx$ and Allied Forms in Legendre's Functions, between Arbitrary Limits: R. Hargreaves.—The Character of the General Integral of Partial Differential Equations: Prof. Forsyth. F.R.S.

FRIDAY, NOVEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Light, Visible and Invisible: Prof. S. P. Thompson (Macmillan).—Chauncy Maples, D.D., F.R.G.S. (Longmans).—Cheltenham as a Holiday Resort: S. S. Buckman (Cheltenham, Norman).—Twentieth Annual Report of the Local Government Board, 1895–96: Supplement containing the Report of the Medical Officer for 1895–96 (Eyre).—Die Wissenschaftlichen Grundlagen der Analytischen Chemie: W. Ostwald, Zweite Vermehrte Auflage (Leipzig, Engelmann).—The Works of Xenophon, translated by H. G. Dakyns, Vol 3, Part 2 (Macmillan).—Hints to Teachers and Students on the Choice of Geographical Books for Reference and Reading, with Classified Lists: Dr. H. R. Mill (Longmans).—Das Kleine Botanische Practicum für Anfänger: Dr. E. Strasburger, Dritte Umgearbeitete Auflage (Jena, Fischer).—A Geological Map of the Southerg Transvaal: Dr. F. H. Hatch (Stanford).—Map of the Transvaal, showinn Physical Features, &c.: Dr. F. H. Hatch (Stanford).—My Fourth Tour in Western Australia: A. F. Calvert (Heinemann).

PAMPHLETS.—A Popular Introduction to the Study of the Sun: G. M. Knight (Philip).—Reforms needed in our System of Elementary Education: T. C. Horsfall (Manchester, Cornish).

SERIALS.—Chambers's Journal, November (Chambers).—The Record of Technical and Secondary Education, October (Macmillan).—Natural Science, November (Dent).—Mittheilungen der Prähistorischen Commission der Kais. Akademie der Wissenschaften, 1 Band, No. 4 (Wien).—Journal of the Royal Microscopical Society, October (Williams).—Contemporary Review, November (Isbister)—Good Words, November (Isbister).—Sunday at Home, November (Isbister).—The Transactions of the Royal Irish Academy, Vol. xxxi. Part 4 (Dublin).—National Review, November (Arnold).—Humanitarian, November (Hutchinson).—An Illustrated Manual of British Birds: H. Saunders, 2nd edition, Part 1 (Gurney).

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THURSDAY, NOVEMBER 11, 1897.

MIMICRY IN BUTTERFLIES AND MOTHS.[1]

Researches on Mimicry on the Basis of a Natural Classification of the Papilionidæ. Part ii. *Researches on Mimicry.* By the late Dr. Erich Haase, Director of the Royal Siamese Museum in Bangkok. Translated by C. M. Child, Ph.D. Pp. 154, and 8 coloured plates. (Stuttgart: Ernin Nägele. London: Baillière, Tindall, and Cox, 1896.)

II.

WE have now to inquire as to the treatment accorded to Haase's work by publisher, translator, and editor.

The eight coloured plates are perhaps the most satisfactory feature of the work as it appears in this country. The English translation is limited to Part ii. of Haase's complete memoir, of which the plates still retain the numbering, viz. 3, 4, 9, 10, 11, 12, 13, and 14. In spite of this, there are frequent references in the text to the other plates (*e.g.* Plate i.) without the slightest indication that the plate in question is not to be found. This is all the more tantalising inasmuch as some of the most interesting figures, viz. those of *Papilio merope* and its allies have their place in the omitted plates.

References to the parts which are not translated appear in the irritating form of "Part i., pages — —," the exact page of the German original being given in the margin, or, as on p. 35, withheld altogether.

The quality of type and paper leave nothing to be desired, and it is very unfortunate that these great advantages should be rendered of little avail for the want of an intelligent proof-reader, to say nothing of an editor.

The names of authorities quoted are frequently misspelt: thus, Jenner Weir appears as J. Wier on p. 12, while on p. 20 it is rendered J. Weis; de Saussure is de Saussare (p. 6); Grose-Smith is rendered by Grosse-Smith (p. 84); Mansel Weale by Wheale (pp. 45 and 104); J. W. Slater by J. W. Sclater (p. 95); while in the footnote of the same page the name appears as F. M. Sclater. Mr. A. G. Butler and the present writer are let off comparatively easily with the initials A. E. B. (p. 33) and E. G. P. (p. 20).

Even more misleading are the frequent mistakes in scientific names, such as *candata* for *caudata* (p. 32), *Euploræ* for *Euplœæ* (p. 25), *Argynns* for *Argynnis* (p. 119), *Decopeia* for *Deiopeia* (p. 98), *biconius* for *bicornis* (p. 147), *Cheysomelid* for *Chrysomelid* (p. 137), *Glancopid* for *Glaucopid* (p. 73), &c. Then avian is rendered by arian (p. 126), while genus becomes ganus (p. 137). The words Pierinæ and Pieridæ are both used; but the combination of these into Pieridinæ (p. 64) is, I believe, peculiar to this volume. A conspicuous and important position is no guarantee against the most absurd errors. In the heavily-printed headings of important sections of the work, Coleoptera appears as Colcoptera (p. 18), Mimetic as Numetic (p. 19), and Hypolimnas as Hypolinopas (p. 29).

After this it is hardly necessary to allude to the innumerable blunders in ordinary words which are scattered thickly throughout the work. Some of these mistakes are, however, worthy of quotation merely to illustrate some of the curious forms which printers' errors may assume. Thus we meet with "altoogether to slight" (p. 137), while "exclusively" becomes "exclusive by" (p. 119); in "a bee" the words are transposed and fused, becoming "beea" (p. 72). In many cases the wrong letter makes a different word, which may sometimes be mistaken for that which was intended. Thus "ledges" becomes "lodges" (p. 7), "wavy" becomes "wary" (p. 148), "than" becomes "then." It is an interesting speculation to attempt to determine the intended word in the passage which tells us that the Jamaican *Aristolochia grandiflora* emits such an unpleasant smell that "even pigs she from eating it" (p. 97).

Errors of punctuation also occur, sometimes producing the most ludicrous effect, sometimes merely serving to confuse the reader. The Zygænidæ are described as possessing "large legs beset with numerous spines and short antennæ" (p. 73). A good example of the difficulties introduced by want of style and want of correct punctuation is to be found in a sentence on p. 123: "This similarity among inedible species is, as first pointed out by Fritz Müller and Wallace, *mutually advantageous* to the participants in the resemblance for the type of the immune forms becomes in this way *more distinct*, being expressed in few forms." The reference number is so displaced on p. 98, that "Indian Danaids" appear in the footnote as "this sluggish little Bombycid," and it becomes a matter of conjecture as to the insect which is really intended—probably *Deiopeia*. On p. 14 *centrali* is hyphened with *Biologia* instead of with *americana*.

The names of species are generally printed in italics, but curious exceptions occur. Thus on p. 127 the generic name of a species is printed in ordinary type, the specific in italics, an arrangement which is reversed with another species on p. 55; while on page 58, half of the word Passifloræ is printed in one way and half in the other.

We have now to judge how far the translator has given us a fair idea of the immense amount of labour which the author bestowed upon his work. The two chief and essential qualifications for a translator are (1) the knowledge of the two languages, and especially of that into which the work is being rendered; (2) knowledge of the subject-matter, without which the most skilled linguist must come hopelessly to grief.

The knowledge of English possessed by the translator of Haase's work may be inferred from the frequency with which a sentence is preceded by an unnecessary and inexplicable "thus," by the use of the word "momentarily" where we should say "temporarily" (114), of "irrelevant" for "unrelated to" (136), of "aside from" for "besides." On p. 105 it is suggested that the "secondary shading of the wings" of certain butterflies may be "a reaction of the *morbidly sensitive* organism against the physical and chemical influences of the hotter climate." On p. 100, pupæ are said to be protected "by often very artistic cocoons"

All those who see much of children at Christmas-time will have had occasion to notice the printed directions accompanying toys which bear a familiar legend. It will often be observed that these directions remain as a constant source of amusement long after the toys themselves have come to their natural end in the dustbin.

[1] Continued from p. 4.

Any one who is familiar with this class of literature will probably infer that the following sentences were also "made in Germany."

"Trimen also observed that an Acacia tree with exuding sap, the sporting ground of the sucking insects, was also visited by predatory Mantids, which found here numerous victims" (p. 40).

"I regard these females therefore, not as does Butler, as mimics of the *Euplœæ*, but as normally coloured, for they resemble closely other *Satyridæ*" (p. 32).

"As much as the coloration of the wings varies within narrow limits in different species of this genus, it is, however, in general similar" (p. 26).

"In the Neotropic genus *Phoraspis*, Serv., the forms with a light longitudinal fillet on the indistinctly ribbed elytra and with pronotum cleared to a glassy appearance on the sides, between which the head appears, resemble somewhat the 'Lampyridæ'" (p. 7).

Seitz is made to say that a nauseous odour is emitted by a certain butterfly (*Eueides*) "only when danger threatens or on direct insult." He is thus made to describe the evidence on which this conclusion was based: "I approached two of these insects during copulation and smelled of them, but could perceive nothing." Such conduct is evidently regarded as not sufficiently insulting to produce the desired effect (pp. 56, 57).

Schilde is represented as saying

"that the (mimetic) *Pieris* 'would become extinct if it were not otherwise compensatingly protected in its own garb, long before the first traces of the aping of the gaily-colored species had been teleologically selected on its white wings'" (p. 124).

The mimetic female *Pierinæ*, we are told on p. 66,

"flutter in low flight and little exposed through the thickets visiting at most the edge of the forest, where their models suck the juices of flowers."

Haase argues that in certain butterflies transparency is even more effectual for protection than a conspicuous "warning" appearance; the metaphor in which he expresses this opinion is thus rendered on p. 98:

"We must conclude that for protection against the obstinate enemies a 'tarn cap' is more advantageous than a 'gorgon's head.'"

We have now to inquire whether the translator possessed the requisite knowledge of the details of the subject-matter. The following examples will show that he must have been absolutely ignorant of it; and the blunders due to this cause are far more injurious than the others already treated of, and detract in a still more serious manner from the scientific value of the work. The want of technical knowledge causes many words and sentences to be rendered in a manner entirely at variance with their true meaning.

Thus the hooked hairs of certain crabs are spoken of as "angling hairs" (p. 151). The *Attidæ* are said to "suffer greatly from the persecutions of their spider-enemies" (p. 5): the author evidently stated that they suffered from the attacks of the "enemies of spiders." The "lepidopterologist" (p. 123) may well fail to recognise the familiar cyanide bottle under the description of "potassium glass" (p. 47).

Even the familiar words "Lepidoptera," "butterfly," "moth," are sometimes used in an entirely wrong sense. Thus on p. 138 we are told that "Mimicry of members of *other genera of the same subfamily* occurs not only in the Lepidoptera, but also among *Danainæ*" and several other well-known Lepidopterous sub-families. Speaking on p. 37 of a moth (*Chalcosia*), the author is made to say that "the pinned insect was more tenacious of life than any other butterfly with which I am acquainted." On p. 146 the common hawk-moth *Smerinthus ocellatus* is spoken of as a butterfly. The "empty pupal case of a butterfly," alluded to on pp. 147 and 154, should certainly be the "empty cocoon of a moth." Again, the word for butterfly is sometimes (p. 38) rendered by *Papilionidæ*. By a similar blunder, on p. 41, the genus *Papilio* is itself excluded from the *Papilionidæ*.

Instead of rendering the German descriptive terms by the corresponding English ones, the translator merely attempts a literal translation of the former. The absurd results of this procedure are so thickly spread over the book, that they form one of its worst features. Thus we are constantly told of "shaded," "secondarily shaded," and "cleared" wings, of "fillets" (*e.g.* "four orange fillet remnants," p. 7, "cellular fillets," p. 29), and of "limbal" markings. We read of the "yellow flanks" of a female Papilio (p. 93), and of "smeary" larvæ (p. 65). A "New Hollandish" genus (p. 133), the "lemon butterfly" (p. 148), and the "stem" of the aculeate abdomen (p. 134), are doubtless intelligible to an entomologist, although not the terms we should employ in this country.

I should wish, in conclusion, to express regret that Haase's painstaking and, in many respects, useful work—marred as it is by excessive arrogance, by its imperfect acquaintance with the literature of the subject, by its numerous errors, and by the rashness and frequent absurdity of its confident conclusions—should have been introduced to the English-speaking public in a form which is completely destructive of such merits as it may be fairly claimed to possess.

E. B. P.

THE ACTION OF MEDICINES.

Lectures on the Action of Medicines: being the Course of Lectures on Pharmacology and Therapeutics delivered at St. Bartholomew's Hospital during the Summer Session of 1896. By T. Lauder Brunton, M.D., D.Sc., LL.D., F.R.S., F.R.C.P., &c. 8vo. Pp. xv + 673. (London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1897.)

DR. BRUNTON, in his preface to this substantial volume, writes as follows:

"I acknowledge at once that the lectures are imperfect. They are redundant in some parts and scanty in others; they are not well adapted for the purpose of cramming, and any man who tries to pass an examination upon them alone will not be at all likely to get the maximum number of marks. But I do not think that lectures are intended for the purpose of cramming. Their use is not to supply the student with all the information he needs, but to awaken his attention, to excite his interest, to impress upon him certain points which will form a nucleus for his knowledge, and around which he may afterwards group more information."

Wise and experienced teachers will regard as a merit, what the author thus modestly admits as an

imperfection. His lectures, like Sir Thomas Watson's and others that are placed among the classics of medicine, do not contain a complete statement of all that can be said on their subject; but they do excite the reader's interest, they do arrest his attention, they make him perforce reflect for himself, and they in this way truly subserve his education in the best sense of that much-abused word.

The lectures must have been delightful to listen to; every sentence bears the impress of their author's genial personality. Nothing connected with drugs and their actions is without interest to him; and he assumes, and rightly assumes, that his hearers must share his interest. His style is artistically simple and direct; allusions, illustrations, analogies, experiences, anecdotes, are introduced at every turn, and the light of his gentle humour plays effectively over many a passage. The old-fashioned *materia medica* lecture used to be regarded as the driest and dullest of the medical course: Dr. Brunton has transfigured it into one of the brightest. It is his special merit that the change has been brought about without the least sacrifice of scientific method or scientific precision; for the whole book is instinct with the spirit of modern physiology and pathology. Empirical *axiomata media* cannot yet be wholly excluded from therapeutics, but Dr. Brunton is never content with a mere induction from experience when it is possible to suggest a rational explanation. And if the suggestion is capable of being tested by experiment, the experiment is made.

"I was once demonstrating the action of ammonia before a class here many years ago, and showed that if you held either ammonia or chloroform before the nose of a rabbit the heart stopped instantaneously. This stoppage of the heart takes place reflexly through the fifth nerve as an afferent, and through the vagus as an efferent nerve. After the lecture was over, a student came up to me and said: 'If ammonia held before the nose stops the heart, how is it that it is of use in fainting? It ought to be exceedingly bad in fainting, and yet everybody knows it is good.' Well, I simply did not know. I said: 'I think it may possibly be that it tends at the same time to cause a deep inspiration, and thus stimulates the heart indirectly.' But I was not satisfied with this explanation, and so I put the question to the test of experiment. I found the answer to be this: At the same time that you stop the heart through the vagus by ammonia or any other irritating volatile substance held before the nose, you stimulate reflexly the vaso-motor centre, cause contraction of the arterioles, and raise the blood-pressure enormously."

This specimen is typical; it can be paralleled by a multitude of others, and it exemplifies at once the style and the spirit of Dr. Brunton's teaching.

The general plan of the book follows the lines of the schedule recently adopted by the Royal College of Physicians as defining the scope of an examination in pharmacology for students aspiring to their licence. Before, however, any examination had been held, a retrograde step was taken by a majority of the Fellows, and this special examination was abolished. Among the grounds alleged for so unusual a course were the supposed vagueness of the limits of the science, and the absence of appropriate text-books. It cannot be doubted that, had the present work been then accessible to students, these grounds of objection would have proved untenable. "The action of medicinal agents on the body in health and disease" forms, indeed, the essential scientific foundation for the "practical art of therapeutics" which every medical licentiate is assumed to have acquired; without this foundation he must needs be a mere empiric. The author has shown that the ascertainable facts in reference to medicinal action constitute already a coherent and orderly body of knowledge, and that future progress in rational treatment is dependent on the pursuit of the methods of scientific pharmacology in this sense of the term. He has furnished the student with an excellent guide to both facts and methods, and has thus removed the last excuse for the maintenance of mere rule-of-thumb tradition. It is to be hoped that, at no distant day, the Royal College will reconsider its last decision in the light of better knowledge and broader conceptions of medical education.

In accordance with the plan of the above-mentioned schedule, the actions of medicines are first considered from a physiological point of view, as they affect the various functions and systems of the body, normal or morbid. The movements of the alimentary canal and digestion; the composition of the blood, nutrition and metabolism; the heart and blood-vessels, and the circulation; disorders of the circulatory function, such as inflammation; absorption of inflammatory products; secretion and excretion; respiration; the nervous system and sleep; the sensory functions and pain; the reflex and motor activities of the nervous system; the regulation of bodily temperature and fever; specific poisons and infections; all of these are capable of being altered, modified, or controlled by medicinal agents, and the mode in which the latter exert their special action and produce their recognised effects is fully set forth.

But in many cases the practitioner has to ask himself not only what agents at his command are capable of modifying a given function in a desired way, but also what organs or functions may be affected by a given remedy administered in a particular manner. It is therefore necessary again to traverse the ground, at least in part, arranging the subject-matter under the heads of the chief medicines and therapeutic methods in ordinary use, and summarising their numerous primary and secondary actions on the body at large. The last half-dozen chapters do this clearly and succinctly. There is perforce some repetition of the earlier chapters; but the student is made to feel that not a page could be dispensed with, and the book ends long before his attention is fatigued or his interest exhausted.

It would, however, be a mistake to regard the book as good for students only: it is full of wise aphorisms and sagacious hints of the greatest value to men engaged in actual practice. There is scarcely a page from which even a practitioner of long and wide experience could not cull a suggestion, leading to the better use of his familiar tools, or to the elucidation of some old-standing puzzle. Alike to the student who is learning the subject for the first time, to the medical man in search of light and leading in the perplexities of treatment, and to the "intelligent reader" who desires to appreciate the advances made by modern medicine to a place among the sciences, we can cordially commend this fascinating work.

ORGANIC CHEMICAL MANIPULATION.

Organic Chemical Manipulation. By J. T. Hewitt, M.A., D.Sc. Pp. xi + 253. (London: Whittaker and Co., 1897.)

THIS is in some respects a useful little book, but it might easily have been made much more useful. It is divided into two parts. The first portion—102 pages—is occupied mainly with a very brief description of processes of purifying organic substances, namely, crystallisation, distillation, melting-point determination, and sublimation; and a short outline of the processes of ultimate organic analysis. A large part of the matter in this section of the book is what the student will find in almost any text-book on quantitative analysis, and might perhaps with advantage have been omitted here, and its space devoted to an extension of the matter in Part ii., and to more exact and detailed directions for carrying out the "manipulations" therein described. The second part of the book, covering 150 pages, is on the "preparation of organic substances." This, at least, is what it professes to be; but there is so much "descriptive" matter distributed throughout it, that in parts it more resembles a simple text-book on organic chemistry, with experiments thrown in. For example, after giving very fair directions for the preparation of methane from sodium acetate, and the performance of two or three experiments illustrative of its properties, the author proceeds to describe, in the true text-book style, the various other methods for the preparation of marsh gas. Thus:—

> "To obtain perfectly pure methane, zinc-methyl is decomposed by water:
>
> $$Zn(CH_3)_2 + 2H_2O = 2CH_4 + Zn(OH)_2.$$
>
> An interesting synthetical method for the formation of methane was discovered by Berthelot, who led a mixture of sulphuretted hydrogen and the vapour of carbon disulphide over red-hot copper:
>
> $$CS_2 + 2H_2S + 8Cu = CH_4 + 4Cu_2S.$$
>
> The following general methods of the formation of paraffins, *i.e.* hydrocarbons of the general formula $C_nH_{2n} + 2$, may be mentioned."

And so on, and so on (pages 106–7).

Again, we read:

> "The aldehydes are nearly always produced by the oxidation of the corresponding primary alcohols, the process being usually carried out with potassium dichromate and sulphuric acid, *e.g.*:
>
> $$3CH_3CH_2OH + K_2Cr_2O_7 + 4H_2SO_4 = 3CH_3 . CHO + K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O.$$
>
> Another way is to distil a mixture of the barium or calcium salt of an acid with the corresponding formate; the following reaction then takes place:"

And so on for nearly three pages. This is all very true, and good enough of its kind; but it savours too much of the ordinary descriptive text-book, and too little of "Organic Chemical Manipulation."

Why such "manipulations" as taking the density or specific gravity of an organic liquid, or finding the optical activity of a sugar solution, should be introduced in the part of the book supposed to be devoted to the "preparation of organic substances" is not quite evident. The directions given for the preparation of the various compounds dealt with, although often very good, are not always above criticism; for example, in the preparation of ethylene the student is directed to mix 25 grams of alcohol and 150 grams of strong sulphuric acid in a flask of two or three litres capacity. Why such an enormous flask? The total volume of the mixture is barely 100 c.c., with at most another 50 c.c. to be added as the operation goes on, and to employ a flask of 20 or 30 times this capacity is simply ridiculous. Without adopting any of the well-known precautions against frothing up (which, by the way, are not hinted at), if the flask is not more than one-fourth filled with the liquid it will be amply large enough. The author then goes on to direct that the gas shall be passed through two wash-bottles in succession,

> "the first being charged with concentrated sulphuric acid to remove the vapours of alcohol and ether, the second with caustic soda solution to hold back any carbon dioxide, and towards the end of the experiment sulphur dioxide."

As water, in the form of steam, is expelled from the generating flask in considerable quantity along with the ethylene, the strong sulphuric acid in the first wash-bottle will soon become *weak* sulphuric acid, and moreover will become so hot as to render the fracture of the bottle extremely probable. If these two wash-bottles are to be used, the order should be reversed; but as a matter of fact they are quite unnecessary. If the temperature is properly regulated (for which purpose a thermometer should be passed through the cork of the generating flask, and should dip into the liquid), practically no ether is produced; and if the gas is passed through a single wash-bottle containing water, any alcohol which passes over will, for the most part, be retained there. So also will any sulphur dioxide, should the operation be pushed to such extremes that this gas is generated. Any traces of carbon dioxide which accompany the ethylene are quite immaterial, but they can if necessary be absorbed by the addition of a little caustic soda to the water in the pneumatic trough.

Lastly, after directing that the gas is to be passed through two bottles containing bromine, for the preparation of ethylene dibromide, the author adds, "the tube leading from the bromine absorption bottles must not open directly into the air, but should go into the bottom of a lime-tower which is charged from the constriction upwards with alternate layers of broken glass and soda-lime." Why not simply bubble the gas through a little caustic soda in a small beaker?

On p. 112 the following equation is given for the preparation of cuprous acetylide:—

$$C_2H_2 + CuCl + NH_3 = C_2HCu + NH_4Cl.$$

One would like to know upon whose authority this is given.

The book contains sixty-three illustrations, most of which are of the very roughest description. Fig. 36, p. 67, represents a crucible balanced in an impossible position upon a pipe-clay triangle. Again, in Fig. 60, p. 183, it is difficult to see why an exit tube is to be

soldered into a hole in the tin can, instead of using the obvious two-holed cork which will carry both the safety tube and the exit tube.

In spite of these faults, however, the book will no doubt be of some use both to teachers and students of practical organic chemistry classes. N.

OUR BOOK SHELF.

Nights with an Old Gunner, and other Studies of Wild Life. By C. J. Cornish. With illustrations. Pp. xii + 307. (London: Seeley and Co., Ltd., 1897.)

MR. CORNISH'S books are widely known, and thoroughly deserve their popularity. He delights in the observation of live animals, especially birds; he describes with detail, yet with animation; and his sketches are rich in human interest. Few better books could be offered to a young fellow fond of nature, but not loving to take his pleasure too seriously. They inspire the love of close observation, and will help to make naturalists of a particularly good kind—men who will study their animals alive, and amidst natural surroundings. The illustrations are attractive, and some of the photographs from life included in this volume are acquisitions to natural history.

Critics are bound to be critical, and we shall notice the trifling matters which we would see amended in another edition. A naturalist, bred in another part of England, may be puzzled by such local words as "marrum grass," "crab grass," and "king crab." The present writer wants to know what they are, but cannot easily find out. The comparison of the shrimp and prawn (p. 87) is not exact, and we are startled to read of the hundred mouths of the sea-anemone (p. 81). A little more information might have been given about the food, and especially about the winter-food, of the beaver. This would have led to an explanation of the purpose of the dam. But Mr. Cornish does not attempt to tell all; what he tells is told so pleasantly that we long for more. L. C. M.

Untersuchungen über den Bau der Cyanophyceen und Bakterien. By A. Fischer. Pp. 132, and 3 plates. (Jena: G. Fischer, 1897.)

THIS little volume is very full of information on methods of fixing and staining, and on the results of high power observations of these minute organisms. Fischer's principal conclusions are that staining depends on physical and not chemical properties of the dyes and cell-substances, and consequently there are no such things as nuclear stains.

That the cell of the Cyanophyceæ consists of a central body clothed with a true chromatophore and devoid of a nucleus.

That neither the sulphur-bacteria nor the other schizomycetes examined contain a nucleus, and that the interpretation of bacteria as composed of a nucleus denuded of protoplast is incorrect. Also that "Die starke Färbbarkeit der Bakterien mit Kernfarbstoffen ist ein Mythus."

With regard to these and many other points concerning the structure of the bacterium-cell, it would appear probable that Bütschli—whose conclusions are especially criticised—should have something to say: and judging from certain extremely pretty preparations of *Tolypothrix* which Dr. Scott exhibited a few years ago, and from recent work by Mr. Wager on the nuclei of bacteria, it may be that Fischer's interpretation of the stained groups of chromatin-like filaments, granules, &c., as "probably reserve materials," will not be accepted as final.

In any case, the work is a most acceptable contribution to the controversy on this extremely difficult subject, and two of the three plates suggest the question why can we so rarely have English memoirs so well illustrated?

Electricity and Magnetism for Beginners. By F. W. Sanderson. Pp. ix + 244. (London: Macmillan and Co., Ltd., 1897.)

THIS little book is "intended to form a first course for boys who have already learnt the elements of mensuration, statics, dynamics, and heat"; the object being "to introduce the student to the principal laws of" electricity and magnetism, "and give him a working knowledge of the quantities involved."

This object is, on the whole, well attained, though we cannot help thinking that the book would be more valuable to beginners if it covered less ground, and dealt with the elementary portions at somewhat greater length.

The experiments described are well chosen and well arranged. It is intended that the student shall repeat them himself, and for this purpose they are admirably adapted, the apparatus required being of the simplest character. The diagrams, too, are excellent, both in execution and design.

Each chapter ends with a set of numerical examples.

Altogether, a boy who has mastered the book will possess a very creditable acquaintance with the elements of his subject. A. P. C.

Organic Chemistry for the Laboratory. By Prof. W. A. Noyes, Ph.D. Pp. xi + 257. (Easton, P.A.: Chemical Publishing Company, 1897.)

IN this attractive-looking and admirably printed work the chief practical methods of modern organic chemistry are illustrated by directions for the preparation of a large number of compounds by means of typical reactions. The various substances involved are classified according to their constitution, one chapter of the book dealing with acids, another with hydrocarbons, &c., and in all cases the chemistry of the reactions is discussed. Nearly a hundred different preparations are described, some of them of considerable difficulty; but in all cases the directions are clear and sufficient, without being unnecessarily detailed, whilst copious references to original literature are given. The book is intended to serve both for advanced students and for beginners; but, like many other works on the same subject, it is somewhat lacking in suitable experiments to illustrate the earlier portion of the lecture course from which the student derives his acquaintance with the theoretical side of the science. A. HARDEN.

The Reliquary and Illustrated Archæologist. Edited by J. Romilly Allen. New series, vol. iii. Pp. 256. (London: Bemrose and Sons, Ltd., 1897.)

THIS fine volume does credit to British archæology. It is made up of the four quarterly numbers issued this year, and is the most attractively illustrated publication that has come before us for some time. The periodical is, to quote the sub-title, "devoted to the study of the early Pagan and Christian antiquities of Great Britain; mediæval architecture and ecclesiology; th development of the arts and industries of man in the past ages; and the survivals of ancient usages and appliances in the present." The volume has thus a very comprehensive scope, and it contains articles of interest to every archæologist, numerous critical reviews, and notes on archæology and kindred subjects.

The Commercial Uses of Coal Gas. By Thomas Fletcher, F.C.S. Pp. 104. (Warington, Manchester, and London: Fletcher, Russell and Co., Limited).

GAS engineers and fitters will find this little volume, which is a supplement to one on "Coal Gas as a Fuel," worthy of attention. The book contains many notes which will be found particularly serviceable in workshop practice, and in the laboratory as well. One of the chapters "On the Use of the Blowpipe," for workshop purposes, deserves special mention. The book may be taken as a statement of the advantages of coal gas as a fuel.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Law of Divisibility.

MAY I briefly supplement my former letter by a few suggestions for the development of the above law?

(1) When δ (or a multiple) appears in N, it may be replaced by cyphers.

Thus if $\delta = 3$, for 235697 write 205007,
$= 7$, do. 200690 or 230090
$= 23$, do. 5007.

(2) Any member of the recurring period r_n may be represented by its negative complement which reaches its maximum at $\frac{1}{2}\delta$.

Thus if $\delta = 7$, period $= \pm 1, 3, 2$;
$= 11$, do. $= 1, -1$;
$= 37$, do. $= 1, 10, -11$;
$= 41$, do. $= 1, 10, 18, 16, -3$.

(3) If the final remainder be negative, its complement must be taken.

Thus if $\delta = 7, 17, 29, 41,$
and $R = -2, -14, -25, -32,$
true value $= 5, 3, 4, 9$.

(4) Final remainders may be found by repeated applications of the requisite formula.

$$\begin{aligned} \text{Let } \delta &= 41, \\ N &= 3205175 \text{ or } 3000175 \\ N_1 &= 5 + 70 + 18 + 30 \\ &= 123 = 3 + 20 + 18 = 41, \\ \text{Let } \delta &= 37, \\ N &= 87172 \\ N_1 &= 2 + 70 - 11 + 7 + 80 \\ &= 159 - 11 = 148 = 8 + 40 - 11 = 37. \\ \text{Let } \delta &= 7, \\ N &= 8638 \\ N_1 &= 8 + 9 + 12 - 8 = 21 = 1 + 6 = 7. \end{aligned}$$

(5) The group principle may be applied to $\delta = 99, 999, 9999$ &c., where $N_1 = a_2 + b_2 +$ &c.; $a_3 + b_3 +$ &c.; $a_4 + b_4 +$ &c. The first is a test for 11, the second for 37, the third for 101.

(6) Another method is the following:—

$$\begin{aligned} \text{Let } N \div \delta + 1 &= Q_1 \text{ with remainder } r_1, \\ Q_1 \div \delta + 1 &= Q_2 \quad \text{do.} \quad r_2, \\ Q_2 \div \delta + 1 &= Q_3 \quad \text{do.} \quad r_3, \\ \&c. &= \&c. \end{aligned}$$

$$\begin{aligned} \therefore N &= (\delta + 1)Q_1 + r_1 \\ &= (\delta + 1)^2 Q_2 + (\delta + 1) r_2 + r_1 \\ &= (\delta + 1)^3 Q_3 + (\delta + 1)^2 r_3 + (\delta + 1) r_2 + r_1 \\ &= \&c. \end{aligned}$$

Eliminating multiples of δ, we get, when $Q_n = 0$,

$$N_1 = r_{n-1} + r_{n-2} + \&c. + r_1.$$

If $\delta \pm a$ be used, we get

$$N_1 = a^{n-1} r_{n-1} \pm a^{n-2} r_{n-2} + \&c. \pm r_1.$$

Putting $a = 1, 2, 3$ we may deal with a wide series of primes, such as

19, 29, 59, 79, 89, 109 &c.
31, 41, 61, 71 &c.
23, 43, 53, 73, 83 &c.;

also with composites, as

119 for 17 and 7, 129 for 43 and 3,
159 for 53 and 3, 201 for 67 and 3,
301 for 43 and 7, 501 for 167 and 3, and so on.

As examples, let $\delta = 399 = 3 \times 7 \times 19$.

$$N = 8293177893$$

$$\begin{aligned} \div 400^3, \; r_1 &= 293 \\ r_2 &= 144 \\ r_3 &= 232 \\ r_4 &= 129 \end{aligned}$$

$$400)\, 798 = 398$$
$$1$$
$$399 = 19 \times 7 \times 3.$$

Let $\delta = 299 = 13 \times 23$,
$N = 166371972$
$\div 300^4$, $r_1 + r_2 + r_3 + r_4 = 72 + 173 + 48 + 6 = 299$.

Let $\delta = 501 = 167 \times 3$
$N = 640550043$
$\div 500^4$, $5 - 62 + 100 - 43 = 0$.

From the foregoing I have derived many simple rules no requiring division. HENRY T. BURGESS.

Tarporley, West Norwood, November 4.

A Link in the Evolution of a Certain Form of Induction Coil.

AT a time when much interest is taken in the oscillatory electric discharge and its effects, it may not be out of place to mention that a link in the evolution of the Tesla coil is to be found in a paper by Dove (Royal Academy of Sciences, Berlin, October, 1844; *Electrical Magazine*, vol. ii. p. 67). It is as follows:—The external coatings of two Leyden jars were connected together by a wire spiral. This spiral was surrounded by a secondary insulated spiral. When the jars were so charged that a spark was produced on joining their internal coatings, electricity was induced in the secondary spiral. If to this arrangement of Dove, a cistern of insulating oil be added to contain the coils, and the jars, furnished with a spark gap, be charged from an induction coil, we have one of the combinations which has given such excellent results in the hands of Tesla. In 1831 Faraday ("Experimental Researches," vol. i. § 24) arranged an experiment to discover whether the electrical discharge of a Leyden jar would produce an induced current in his induction coil; he writes: "Attempts to obtain similar effects by the use of wires conveying ordinary electricity (*i.e.* from a jar) were doubtful in results."

The combination due to Dove, is probably the earliest instance of an apparatus in which electrical oscillation in one circuit set up a definite disturbance in a neighbouring coil.

Oxford, November 8. F. J. JERVIS-SMITH.

The Leonid Meteors.

I SHOULD be glad to receive accounts of any brilliant meteors that may be observed on the nights of November 13 and 14 next, for the purpose of computing their real paths in the air. The date and time of appearance of each object should be given, together with its apparent magnitude (compared with the moon, planets or brighter stars), observed course amongst the stars in R.A. and Declination, and estimated duration of flight. Though moonlight will be strong, many observers will be on the look-out for the vanguard of the Leonids, so that should any brilliant meteors appear, they are likely to be noticed at several different stations. W. F. DENNING.

51 Brynland Avenue, Bishopston, Bristol.

Insects and Colour.

THE following incident may throw some further light on the subject brought forward by your correspondent, Mr. J. Parkin, in his letter in your issue of November 4, on "A Bee's Movements in a Room." In the year 1893, the humming-bird hawk moth was particularly common here. On one or two occasions, driving out in a little trap, with a Shetland pony, whose head-gear was ornamented with pyramidal blue rosettes, one of these beautiful insects would fly straight at one of the rosettes, and hover over it for a few seconds, though the pony was going at a trot. It would seem that in this case the colour alone was the chief attraction; the odour being insignificant. But there are, I believe, numerous other instances of insects being attracted in the first instance by colour. I may add that these insects visited chiefly the *scarlet* geraniums in my garden.

ALFRED THORNLEY.

South Leverton Vicarage, Notts., November 5.

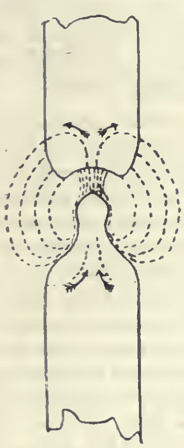
HIGH PRESSURE ELECTRICITY.[1]

THIS book is not a mere ordinary *édition de luxe*, for it is probably the most sumptuous book in connection with electricity that has ever appeared. The life-like vividness of forty-one beautifully executed photographic reproductions of electric brushes and streamers make you hear the banging of the battery of many "ten-gallon" Leyden jars; while the description of these illustrations, from the largeness of the type used, the wide spacing of the lines, the two- to three-inch margin that surrounds them, and the blank page that intervenes between every two pages of printed matter, induces a feeling of luxury in the reader, and makes him hope that the theoretical inferences will be as good as the very thick paper on which they are printed.

Lord Armstrong starts with the very striking experiment which he performed with his hydro-electric machine half a century ago. Two glasses of distilled water were placed near together, and a thread of cotton, which was coiled up in the one, had its end placed so as to dip into the other glass. Then on highly electrifying the glass of water in which the cotton was coiled negatively, and the other glass of water positively, the thread crept out of its glass into the other one, while a stream of water passed in the opposite direction.

From this he has been led to conclude that an electric current consists of two streams—a negative one in the form of a core flowing in one direction surrounded by a sort of sleeve of positive electricity flowing in the opposite direction; and he suggests, on page 24, that instead of negative and positive the names "Inward" and "Outward" would better meet his views.

He cites as an illustration of his theory the formation of the crater at the end of the positive carbon of an electric arc, and the knob at the end of the negative carbon; both of which he considers are produced by the scooping out effected by the "lines of force," which he considers follow some such path as that indicated on the accompanying figure copied from the book.



There are various reasons, however, with which Lord Armstrong is apparently unacquainted, for believing that the scooping-out theory is not correct; for example, when a thin carbon rod is put endways into an arc the rod is simply pointed like a pencil, with no appearance of any directed scooping action. Whereas, if Lord Armstrong's "lines of force" were correct, we should expect to find a cavity scooped out on one side of the carbon rod near the middle of the arc, and another on the other side near the edge. But this only happens when the carbon rod is wide, and is placed so as to split up the arc into two *distinct* arcs.

Some of the illustrations are photographic reproductions of dust figures obtained with brush discharges, while others of them were produced by causing a violent discharge from a large battery of Leyden jars to take place from a metallic disc resting on an insulated photographic plate, the disc being in some experiments positive, in others negative. In other cases two photographic plates were placed back to back with the sensitive sides outwards, and the positive and negative electrodes were placed against the two sensitised surfaces respectively.

The figure formed at the negative electrode was found to be smaller than that produced at the other, and in answer to the question "How can this be reconciled with the assumption that negative and positive action are equal?" the author remarks on page 26:—

"The answer is obvious if we admit that the negative represents suction, and the positive pressure, because in that case the negative flow will be resisted by condensation, while the positive will be helped."

And on page 44 he suggests, as a possible hypothesis, that as in a pump,

"The negative stroke, representing suction, must take the lead of the positive, and will have to draw from a neutral atmosphere. In doing so it will create a deficit in the environment which will aid inductively the impulsive energy of the positive."

On page 49 are described experiments in which negative streams were projected from an annular electrode upon a dust plate with a positive metallic ring beneath, and the author, in reference to the dust figures produced, remarks:—

"Their general appearance is strikingly like pictures of physiological cells; and what is more strange, we see them in every state of fission, from small beginnings to complete separation, and in every case the divided form displays the same internal structure as the original form from which it springs. I have already spoken of electricity as organised motion, and we have here an example of it carried to the very verge of life."

All this is probably intended only as a poetic fancy, but it reads strangely in close juxtaposition with a discussion on matter and motion, ether and atoms.

But, whatever may be the opinion of the theoretical portion of this book, whether we consider that the inward flow of negative electricity and the outward flow of positive are supported by the experiments, there can be no doubt that the illustrations form a series of valuable records of electric discharges.

W. E. A.

[1] "Electric Movement on Air and Water, with Theoretical Inferences." By Lord Armstrong, C.B., F.R.S. Pp. vii + 55, and plates. (London: Smith, Elder and Co., 1897.)

THE REV. P. B. BRODIE, M.A., F.G.S.

IN the death of the Rev. P. B. Brodie geological science has lost one of its oldest cultivators, one who so long ago as 1834 was elected a Fellow of the Geological Society, and who was widely known for his researches on the fossil insects of the Secondary formations of England.

Mr. Brodie, who was born in 1815, was the son of an eminent lawyer, and nephew of the distinguished surgeon Sir Benjamin C. Brodie, Bart. He was educated at Emmanuel College, Cambridge, and coming under the influence of Sedgwick, a taste which he had previously manifested for geology was developed into a life-long enthusiasm for the science.

Entering the Church in 1838, the duties of his calling took him as Curate to Wylye, in Wiltshire, and for a short time to Steeple Claydon, in Buckinghamshire. Later on he became Rector of Down Hatherley, in Gloucestershire, and finally Vicar of Rowington, in Warwickshire. In all these districts he found that a rich harvest of geological facts could be gathered.

His earliest observations were on the Purbeck strata of the Vale of Wardour, and he then discovered many insect-remains, and also the Isopod which was named, by Milne-Edwards, *Archæoniscus Brodiei*. Continuing his researches in the Vale of Gloucester, on the Lias and Lower Oolites, he soon found many unrecorded fossils, and notably many remains of insects, and he thus came to publish, in 1845, his well-known "History of the Fossil Insects in the Secondary Rocks of England." An active member, for a time, of the Cotteswold Naturalists' Field Club, Mr. Brodie was later on a staunch supporter of the Warwickshire Natural History and Archæological Society, and a founder of the Warwickshire Naturalists' and Archæologists' Field Club. He was the life and soul of field-meetings, full

of energy and high spirits; and at the time of his death he was President of both Warwickshire societies.

Mr. Brodie was the author of many geological papers communicated to the Geological Society, the British Association, and various scientific journals. In 1887 the Council of the Geological Society awarded to Mr. Brodie the Murchison Medal for his long and valuable geological labours; an agreeable testimony to good work achieved by one who, all his life, was a dweller in the provinces. H. B. W.

NOTES.

THE Royal Society's medals have this year been adjudicated by the President and Council as follows:—The Copley Medal to Prof. Albert von Kölliker, Foreign Member R.S.; a Royal Medal to Prof. Andrew Russell Forsyth, F.R.S.; a Royal Medal to Lieut.-General Sir Richard Strachey, F.R.S.; the Davy Medal to Dr. John Hall Gladstone, F.R.S.; the Buchanan Medal to Sir John Simon, F.R.S. Her Majesty has signified her approval of the award of the Royal Medals.

THE following is a list of those who have been recommended by the President and Council of the Royal Society for election into the Council for the year 1898 at the anniversary meeting on November 30:—President: Lord Lister. Treasurer: Sir John Evans, K.C.B. Secretaries: Prof. Michael Foster, Prof. Arthur William Rücker. Foreign Secretary: Sir Edward Frankland, K.C.B. Other Members of the Council (the names of new Members are printed in italics): Prof. William Grylls Adams, Prof. Thomas Clifford Allbutt, *Sir Robert Stawell Ball*, *Rev. Thomas George Bonney*, *Prof. John Cleland*, Prof. Robert Bellamy Clifton, Prof. James Alfred Ewing, *Alfred Bray Kempe*, *John Newport Langley*, *Joseph Larmor*, *Prof. Nevil Story Maskelyne*, Prof. Raphael Meldola, *Prof. Edward Bagnall Poulton*, *William James Russell*, *Dukinfield Henry Scott*, Prof. Walter Frank Raphael Weldon.

WE learn from the *Times*, with regret, that in consequence of the heavy demands on his time in connection with his duties at the Natural History Museum, Sir William Flower, acting on medical advice, has reluctantly resigned the presidency of the International Congress of Zoology, which is to meet at Cambridge on August 23, 1898. Sir John Lubbock, on the unanimous invitation of the General Committee, has accepted the office, and will accordingly preside over the Congress.

WE announce with great regret the death, on October 31, of Prof. Haughton, of Trinity College, Dublin. We hope in a subsequent number to publish an obituary notice of Prof. Haughton.

IT is with much regret that we record the death of Herr Geheimrath Prof. Ernst Schering, of Göttingen, who passed away at Göttingen on November 2, at the age of sixty-four, after a long illness. Schering, besides being professor of mathematics at the University, was director of the Magnetic Department of the Observatory, the seat of Gauss' monumental researches in this branch of science.

THE Queen has conferred the Jubilee Medal upon Prof. W. R. Smith, the President of the Royal Institute of Public Health; Sir George Duffey, President of the Royal College of Physicians, Ireland; Sir William Thomson, President of the Royal College of Surgeons, Ireland; and Mr. Walter Hills, President of the Pharmaceutical Society of Great Britain.

PROF. A. A. MICHELSON, of the University of Chicago, has been elected a member of the International Committee of Weights and Measures, in the place of the late Dr. B. A. Gould.

PROF. HENRY S. PRITCHETT, of Washington University, St. Louis, has been appointed superintendent of the U.S. Coast and Geodetic Survey, as successor to General Duffield.

MR. EDGAR WORTHINGTON has been elected secretary of the Institution of Mechanical Engineers, in the place of Mr. Alfred Bache, who has retired on account of ill-health.

SIR WILLIAM GOWERS is to be entertained at dinner by the Society of Medical Phonographers on November 25. The dinner, over which Sir William Broadbent will preside, is to take place at Limmer's Hotel, and has been arranged for the purpose of congratulating Sir W. Gowers upon his honour of knighthood.

THE members of the Gerlache Antarctic expedition were entertained at Rio de Janeiro by President Moraes, and left on October 28 for Buenos Ayres, *en route* to the Antarctic region.

ON the day of his arrival in New York, Dr. Nansen was the guest of the American Geographical Society, which elected him an honorary member and conferred upon him the Cullum Geographical Medal. He was subsequently the recipient of receptions by the Swedish and Norwegian inhabitants of the city, and the National Geographical Society, Washington, and read a paper on "Some of the Scientific Results of Recent Arctic Explorations" before a special meeting of the American Philosophical Society of Philadelphia. He delivered his first public lecture at New York on November 6.

A REUTER telegram from Rome states that for some days past Vesuvius has been in active eruption, and large quantities of lava have been pouring from the crater called Atrio del Cavallo, which was opened in 1895. The lava has divided into two large streams flowing towards Vitrava and the country north of Piano del Tristre respectively, the latter current having again divided into two. The central crater is also distinctly active, throwing forth ashes and lava at frequent intervals.

ON Friday last the inaugural meeting of the recently constituted Röntgen Society took place at St. Martin's Town Hall, when Prof. Silvanus P. Thompson delivered his presidential address, particulars of which we gather as follows from the *Times*. After giving an account of the circumstances in which Prof. Röntgen made his famous discovery nearly two years ago, and referring to the antecedent investigators of whose work that discovery was a development, Prof. Thompson proceeded to make a brief review of what has been achieved with respect to X-radiations. He first discussed the improvements which have been made in appliances, such as in the construction of the tubes, in the materials used for fluorescent screens, in photographic plates, and in the methods of exciting the tubes. Turning to advances in results attained and to applications of the discovery, he said that, excepting only Lister's introduction of antiseptics and the discovery of anæsthetics, no discovery in the present century had done so much for operative surgery as that of the Röntgen rays. The first great application of the rays had been to the diagnosis of dislocations and fractures, the study of bone disease, and the detection of foreign bodies in various parts of the human frame. The localisation of foreign bodies embedded in more transparent tissue had claimed the attention of many surgeons. In this department Mr. Mackenzie Davidson had devised an ingenious apparatus by which any intelligent person could at once localise to within one-hundredth of an inch the exact position, say, of a needle in the hand or foot, the complicated geometry of oblique projection being simplified down by the instrument itself, and reduced to the application of callipers and a divided scale. As regards the physical problems presented by the rays, while there was much progress to chronicle, there was also a vast prospect opening out of problems awaiting

solution. The rays had been found to possess a dissociating, or, more strictly, an ionising effect on the molecules of gases through which they passed, with the result that electrified bodies placed in an atmosphere thus affected were discharged. Further, it was now generally admitted that the rays were not themselves homogeneous—that they were of many kinds, differing in penetrative power, the quality of the mixture depending on the state of the vacuum as well as on the form of the tube and the nature of the emitting surface. The relations between the Röntgen and the kathode rays had been investigated, and important contributions to our knowledge had been made by Mr. A. A. Campbell Swinton, by M. Perrin, and by several Italian investigators. Many speculations had been put forward as to the physical nature of the rays themselves. Crookes, Tesla, and others held them to consist of flights of minute atoms or hyperatoms; on the other hand, there was an hypothesis that they were merely an extreme sort of ultra-violet light, consisting of transverse waves of excessively minute wave length. Jaumann and, apparently, Röntgen regarded them as due to longitudinal vibrations, while Sir George Stokes had put forward the view that they might be transverse waves, not in regular trains, but consisting of innumerable solitary waves. Another wide field of research was opened up by the discovery of other analogous kinds of rays. That the salts of uranium, glow-worms, fireflies, and sticks of phosphorus should be able without any electrical stimulation to give out rays that could produce photographic action through substances that were opaque to every known kind of light was very suggestive, but such rays were not Röntgen rays, and obeyed different laws. It was clear, he concluded, that their little Society had an abundant field.

A SMALL marine laboratory was opened at Cullercoats on the 21st ult. by Principal Gurney, of the Durham College of Science, Newcastle-on-Tyne. It will form a most useful adjunct to the biological department of the college, as well as a centre for the investigations which have been, and are still being carried on by the Northumberland Sea Fisheries Committee. The district owes the laboratory to the public-spirited generosity of John Dent, Esq., J P., the Vice-Chairman of the Committee, who has already made excellent contributions to the knowledge of the local condition of the in-shore waters by the trawling excursions which have been carried on since 1892—the year after the three-mile restriction was adopted. The laboratory was formally handed over to the Sea Fisheries Committee, to be worked in conjunction with the Durham College of Science, Mr. Meek being placed in charge of the scientific operations. A large company assembled, representing the Sea Fisheries Committee, the College of Science, the Natural History Society, and the County Council.

THE inaugural meeting of the seventeenth session of the Institution of Junior Engineers took place in London on Friday last, when Sir Alexander Binnie, the retiring president, presented the Institution premium to Mr. W. R. Beckton for his paper on "The Protection of Buildings from Fire," after which an address, on "Some Aspects of Railway Work," was delivered by Mr. J. A. F. Aspinall, the newly-elected president.

THE twenty-fifth anniversary meeting of the American Public Health Association was held at Philadelphia, October 26–29, Dr. Henry B. Horlbeck, of Charleston, S.C., presiding. Dr. Irving A. Watson, of Concord, N.H., who has for many years acted as secretary, resigned, and was succeeded by Dr. C. O. Probst, of Columbus, O. Among the subjects to which special attention was given were tuberculosis, yellow fever, typhoid fever, and purification of water supply. A sanitary exhibition was held in connection with the meeting.

THE *British Medical Journal* understands that Dr. Wright, the Professor of Pathology at Netley, has had an interview with the Commander-in-Chief on the subject of immunising our troops by vaccination against typhoid. Prof. Wright inoculated all the last batch of candidates for the Indian Medical Service, as well as himself and Surgeon-Major Semple. Lord Wolseley's views on the desirability of affording the protection by vaccination against typhoid to our troops are not yet announced. Any measure that gives a fair chance of mitigating the ravages of enteric among our young soldiers in India is worth a trial, provided no immediate danger or risk is incurred thereby, and no such danger attends the inoculations made in the manner devised by Prof. Wright.

AT a recent meeting of the New York Zoological Society, it was reported by the executive committee that the plans for the zoological park are practically complete, and that it is imperative that the remainder of the first 20,000*l.* of the building fund should be subscribed at once in order that the plans may be submitted to the Park Board without delay.

MR. E. E. HOWELL, of Washington, according to *Science*, has received from the U.S. Government Board of Control an order to construct a relief map of the Yellowstone National Park, for exhibition at the coming Exposition at Omaha. This model, which will be 6 by 6½ feet in dimensions, will be based upon the surveys made by the U.S. Geological Survey, and will represent the geology as well as the topography of the park. The scale will be one inch to the mile, and there will be no vertical exaggeration. The map will, it is said, be very accurate and complete, far surpassing the one made some years ago.

IT is stated that there will shortly be placed on the streets of Paris a number of electric cabs, similar to those with which Londoners are now so familiar. One of the largest Paris cab companies is said to have ordered the construction of 100 of the vehicles.

THE Guildford Natural History Society have decided to present a petition to the Commissioners of Woods and Forests, praying that Walmer Forest may be reserved as a sanctuary for wild birds, in which they, their nests, and eggs, may remain unmolested throughout the year; that it may not be let at any time for game preserving, or for any purpose inimical to bird life; and that it may remain in perpetuity as a national memorial to the great outdoor naturalist—Gilbert White of Selborne, whose observations were made in its neighbourhood.

THE *Journal of the Society of Arts* for the current week publishes a list of the Society's lecture arrangements for the session which is to open on the 17th instant, and from this we extract the following information. Before Christmas a lecture will be delivered by Prof. James Douglas, on "Progress of Metallurgy and Metal Mining in America during the last Half-Century"; and there will be one by Dr. S. Rideal, on "The Purification of Sewage by Bacteria." Among the papers that will be given after Christmas we notice the following:—"The Projection of Luminous Objects in Space," by Eric Bruce; "Aeronautics," by Captain B. Baden-Powell; "The Recent History of Papermaking," by Clayton Beadle; "The Preparation of Meat Extracts," by C. R. Valentine; "Children's Sight," by R. Brudenell Carter. Courses of Cantor Lectures are announced as follows:—"Gutta-Percha," by Dr. E. F. A. Obach; "The Thermo-Chemistry of the Bessemer Process," by Prof. W. N. Hartley; "India-Rubber," by Dr. D. Morris; "Electric Traction," by Prof. Carus Wilson. Two lectures, suitable for a juvenile audience, will be delivered on January 5 and 12, by Prof. William Ramsay, on "Fire."

THE list of lectures to be delivered at the London Institution from November to February next has been issued, and comprises, among others, discourses on "Signalling across Space," by Prof. Silvanus P. Thompson; "On the Frontier of History in Britain," by Prof. Boyd Dawkins; "The Weather Office and its Work," by Charles Harding; "Microbes—Friendly and otherwise," by Prof. W. B. Bottomley; "My Scrambles amongst the Alps," by E. Whymper; "The Position of the Mammalia in the Animal Series," by Prof. G. B. Howes; "Haunts and Habits of British Birds," by R. Kearton; "Incandescent Gas Lighting," by Prof. Vivian Lewes; "Geological Changes beneath the Ocean," by Prof. John Milne; "The First Crossing of Spitsbergen," by Sir W. Martin Conway. The Christmas course for juveniles will be by Mr. F. Enock, who will speak on "Insects at Home, at Work, and at Meals."

PARTICULARS of lectures to working men, in connection with the Royal College of Science, London, have been published. The first course is to be given by Prof. G. B. Howes, and will consist of six lectures dealing with "The Kinship of the Vertebrata." The first lecture will be delivered on Monday, November 15. Subsequent courses will be given by Prof. Le Neve Foster, on mining, and by Prof. Tilden, on chemistry.

THE Sunday Lecture Society has arranged for the delivery, before Christmas, of the following science lectures on Sunday afternoons, at 4 o'clock, in St. George's Hall, Langham Place. On November 14, "Andrée and the North Pole: a Problem of to-day," by A. Montefiore Brice; November 21, "Wireless Telegraphy," by R. Kerr; November 28, "The Land of Dragon Trees," by Dr. D. Morris; December 12, "Colour," by Dr. C. W. Kimmins; December 19, "Some Animal Co-operative Societies," by Dr. Andrew Wilson.

IT will be remembered that in 1895 the original MS. of Gilbert White's "Natural History of Selborne" was sold by Messrs. Sotheby for £294. It is now announced that the same firm will, on November 25, offer for sale an even more interesting batch of writings by the same author. These MSS. are the original letters which were sent by post by Gilbert White to Thomas Pennant between August 10, 1767, and July 8, 1773. These letters were returned to Gilbert White when he first conceived the idea of writing his famous natural history, and from them was drawn up the autograph MS. sold in 1895. The letters are all holograph but four, which are in the handwriting of an amanuensis, signed by Gilbert White, and all but three occupy four pages folio. They are additionally interesting and valuable from the fact that many of the details recorded in them were altered, omitted, or augmented in the published work. The second lot of Gilbert White MSS. is "A Garden Kalendar," dating from 1751 to 1767. It is the author's holograph manuscript, and occupies 424 pages. This has never been published, excepting the portion May 1 to November 16, 1759; it is in the form of a consecutive diary, recording the writer's almost daily operations on his own land, and notes of the results of experiments tried by him in forcing and hothouse work. All the MSS. have been continuously in the possession of the White family.

THE twentieth annual meeting of the Indian Association for the Cultivation of Science was recently held at Calcutta, and a copy of the report adopted upon that occasion is before us. In the course of the year covered by the report, lectures were delivered before the Association upon various divisions of physical and natural science. The Association does not appear, however, to be in a very flourishing condition, and it needs more financial support to put it on a satisfactory basis. In an oration characteristically Indian, the Honorary Secretary urged the necessity of national support in order to make the Institution worthy of India, and pleaded for the endowment of a Science Institute in the metropolis of India. One passage from this aspiring address reads thus:—"Whether our Association will endure to continue to be the regenerating influence for our country may still be in the region of doubt; but if the relationship of cause and effect be eternal, then I can assure you, gentlemen, that circumstanced as our country is it will have to advance, unless otherwise doomed by an eternal decree—it will have to advance, I say with all the emphasis in my power, through the regenerating influence of science and of science alone, and that, therefore, other but similar institutions will have to take the place of ours." Surely such zeal for the cultivation of science, and faith in the social influence of scientific thought, will not go unrewarded.

THE Meteorological Commission of the Cape of Good Hope have published a valuable discussion of the rainfall of Cape Colony for the ten years 1885-94, based upon the monthly and yearly averages for 278 stations, and accompanied by sixteen explanatory maps. The work has been prepared by Dr. Buchan, and has, therefore, every guarantee of scientific accuracy. We extract a few brief notes from his remarks. The annual map shows that the distribution of rainfall over South Africa to the north of the latitude of Clanwilliam (32° 10′ S.) steadily increases from west to east, the amount on the Atlantic coast falling short of 5 inches; whereas on the east coast, for some distance to the north and south of Durban, it exceeds 40 inches. The smallest mean annual rainfall is 2·45 inches at Port Nolloth; it rises above 10 inches over the eastern and southern regions and above 20 inches in certain restricted regions, including Kimberley and the Cape. In the south-east some places have a mean range above 30 inches, the largest being 38·10 inches at Kologha (lat. 32° 31′ S., long. 27° 21′ E.). The heaviest rainfalls in any year are reported from the south-west of the Colony, and the least in the north-west; at Port Nolloth the fall in the driest year does not amount to an inch. Dr. Buchan traces the causes of the very variable rainfall to the geographical distribution of pressure with the resultant winds therefrom, and to the geographical distribution of temperature.

WE are sorry to notice the report that, owing to the present condition of the sugar industry, the publication of *Timehri*, the organ of the Royal Agricultural and Commercial Society of British Guiana, is to cease with the December number. We have on many occasions drawn attention to the magazine, in the contents of which is always to be found something of interest and scientific value.

UNDER the name *Capra mengesi*, Prof. Dr. Noack, of Brunswick, has recently described a new Arabian wild goat, of which he has obtained specimens from Herr J. Menges, the well-known German traveller and collector. The wild goat of Sinai (*Capra sinaitica*) was known to extend along the mountains down the eastern side of the Red Sea, but this new species is from the Hadramaut range on the coast of the Indian Ocean, which was recently visited by the late Mr. Bent, but apparently still requires further investigation. Prof. Noack also describes a new wolf (*Canis hadramauticus*), from the same district.

Petermann's Mittheilungen contains an able paper, by Dr. Gerhardt Schott, on the currents of the Great Banks of Newfoundland. The most interesting results, obtained from discussion of an immense number of observations, are (1) confirmation of the fact that the so-called "Gulf Stream" does not exist as a warm current east of 40° W., and has no rapid movement east of 60° W.; (2) the Labrador current does not anywhere touch the United States seaboard, and has nothing to do with the "cold wall"; (3) on the bank itself there is practically no current. It appears, unfortunately for navigation, that the positions of the warm and cold streams are

not liable to definite changes with the seasons, but are irregular movements difficult to account for.

DR. OTTO NORDENSKJÖLD publishes a short preliminary account of the recent Swedish expedition to Tierra del Fuego, in *Petermann's Mittheilungen*. The expedition consisted of Dr. Nordenskjöld, Herr Dusén (botanist), Dr. Ohlin (zoologist), with two assistants and four porters, and its labours have extended over the summer seasons 1895–96 and 1896–97. From the brief notice published, we gather that contributions of considerable importance to various branches of science, especially, perhaps, geology have been made, the regions explored being of peculiar importance as a connecting-link with the great Antarctic continent.

IN our issue of September 30 (vol. lvi. pp. 520 and 521) we printed a short illustrated account of "The Progress of the Steam Turbine," and many of our readers may like to know that the current issue of the *Electrical Review* contains the first instalment of a lengthy paper on the same subject, which was read a few weeks ago by the Hon. C. W. Parsons before the Institute of Marine Engineers at Stratford.

PART 7 of "Among British Birds in their Nesting Haunts, illustrated by the Camera," by Mr. O. A. J. Lee, has just come to hand. It contains ten plates, and deals with the common guillemot, mallard, razorbill, puffin, crested tit, and red-breasted merganser. The work is published by Mr. David Douglas, of Edinburgh.

A NUMBER of new editions of scientific works have lately been received. First among these publications is the third revised edition of Prof. E. Strasburger's "Kleine botanische Practicum für Anänger" (Jena: Gustav Fischer). In the four years which have passed since the appearance of the second edition, new knowledge has been obtained and is incorporated in the present issue. The work contains 121 figures reproduced from drawings made by Dr. Strasburger, and the text likewise represents the personal observations of the author. Students of structural botany therefore will find the book a trustworthy guide.—A second enlarged edition has been published of Dr. W. Ostwald's text-book of analytical chemistry, entitled, "Die wissenschaftlichen Grundlagen der analytischen Chemie" (Leipzig: Wilhelm Engelmann). The book was reviewed at length in NATURE (vol. li. p. 482) when it first appeared, and it has now been brought up to date. The chief addition refers to electrochemical analysis. The work is not intended for beginners, but to supply adequate theoretical support to the routine work of general analytical chemistry.—Messrs. J. and A. Churchill have published the third edition of "Elements of Human Physiology" by Dr. Ernest H. Starling. The first edition of the book was reviewed in NATURE in December 1892 (vol. xlvii. p. 146), and the chief changes which it has undergone are in the account of the coagulation of the blood, and in the section on the central nervous system.—The elementary stage of the examination in magnetism and electricity, held by the Department of Science and Art, is well covered by the "Elementary Manual of Magnetism and Electricity" by Prof. Andrew Jamieson. The fourth edition, which has just been published by Messrs. Charles Griffin and Co., provides teachers of the subject with a very helpful text-book.—Messrs. Cassell and Co. have sent us a copy of "Electricity in the Service of Man" by Dr. R. Wormell, revised and enlarged by Dr. R. Mullineux Walmsley. We notice that, though the title-page is dated 1897, the preface is dated November 1893, With one or two slight exceptions, the book appears to represent the state of knowledge at the latter epoch.—A revised and enlarged edition of "A Text-book of Physics," by Prof. Edwin H. Hall and Mr. Joseph Y. Bergen, has come to us from Messrs. Henry Holt and Co., New York. The book is an admirable text-book and laboratory manual for beginners in the systematic study of physics. The course covered is that required for admission to Harvard College, where Dr. Hall is professor of physics; and it comprises the leading elementary facts and principles of physics, and quantitative laboratory work referring to them. Teachers of elementary physics in this country would do well to provide themselves with a copy of the book, for it contains numerous ingenious and instructive experiments.—The second edition of "The Practice of Massage: its Physiological Effects and Therapeutic Uses," by Mr. A. Symons Eccles, has been sent to us by Messrs. Baillière, Tindall, and Cox. The first edition was reviewed at length in NATURE of September 3, 1896 (vol. liv. pp. 411 and 412), and we need now only say that the work has been revised and altered to make room for additional matter, especially with reference to the clinical uses of massage, without increasing the bulk of the volume.—The first part of the second edition of the serial issue of Mr. Howard Saunders's "An Illustrated Manual of British Birds" has reached us from Messrs. Gurney and Jackson. This well-known work, which has undergone revision, needs no recommendation from us.

THE additions to the Zoological Society's Gardens during the past week include two Sloth Bears (*Melursus ursinus*, ♂ ♀) from India, presented by Sir Henry D. Tichborne, Bart.; a Macaque Monkey (*Macacus cynomolgus*, ♂) from Tonquin, presented by Miss Rachel Hunt; two Palm Squirrels (*Sciurus palmarum*) from India, presented by Dr. G. H. Nowell; a Long-eared Owl (*Asio otus*), British, presented by Major-General Alex. A. A. Kinlock; a Salt-water Terrapin (*Malæoclemmys terrapin*) from North America, presented by Mr. H. Arthur Clifton; five Tesselated Snakes (*Tropidonotus tesselatus*) from South-east Europe, presented by Herr Carl Hagenbeck; a Mediterranean Peregrine Falcon (*Falco pincus*), captured in the Mediterranean, presented by Captain Watson; ten Paradise Whydah Birds (*Vidua paradisea*), three Pin-tailed Whydah Birds (*Vidua principalis*), four Crimson-eared Waxbills (*Estrelda phœnicotis*), two Red-bellied Waxbills (*Estrelda rubriventris*), two Yellow-rumped Seed-eaters (*Crithagra chrysopyga*), a Singing Seed-eater (*Crithagra musica*) from West Africa, a One-wattled Cassowary (*Casuarius uniappendiculatus*) from New Guinea, two Jackass Penguins (*Spheniscus magellanicus*) from the Falkland Islands, a Black Wood-hen (*Ocydromus fuscus*) from New Zealand, deposited; a Levaillant's Darter (*Plotus levaillanti*) from West Africa, purchased.

OUR ASTRONOMICAL COLUMN.

THE COMING TOTAL ECLIPSE OF THE SUN.—We must congratulate the British Astronomical Association on the energy they have displayed with regard to the coming eclipse in India. We hear that, in addition to the three official expeditions, a fourth, but unofficial, expedition under their auspices will be sent, and that no less than twenty-six observers have come forward to take part in it. It must not be forgotten that considerable expense is attached to such undertakings, and so large a number of observers shows that the general interest taken in such an event is very considerable.

Those who wish to combine an enjoyable winter's cruise in warm climes, with a view of the eclipse thrown in, may have noticed that the Orient Liner's steamer *Orotava* is timed to leave Colombo on January 20 next, and on her homeward voyage from Australia she will be navigated with a view to being on the line of central eclipse at the time of total obscuration. Passengers can thus proceed to Colombo, and after a short stay there, allowing sufficient time to see Ceylon, return by this vessel home, seeing the eclipse on the way. Particulars can be obtained from the Company's offices in Fenchurch Avenue, E.C.

THE BINARY β 395 = 82 CETI.—Dr. T. J. J. See has found a most interesting double system in the binary β 395, which Burnham was the first to detect (1875) and the last to measure (1891·8). The object was detected with Dr. See's usual sweeping power, namely 500, but before the components could be well divided he had to employ a power of 1500. At first the system was supposed to be new, owing to the great difficulty of observing it, but a search showed that it was none other than the system mentioned above, its cordinates being

$$\alpha = \text{0h. 32m. 9·9s.}\ \delta = -25^\circ\ 18'\ 37''\!\cdot\!3\ (1900\cdot0).$$

The most striking feature of this binary is that since its last measurement the orbital motion has been so great that the whole aspect of the system is changed. Nearly one and a half revolutions have been performed since 1875, and, curiously enough, as the companion returned to the same general position in 1886, the "observers of that and the following years failed to recognise that any sensible motion had intervened."

Dr. See has calculated from all the published observations the orbit of this binary (*Astr. Nachr.*, No. 3455), and he finds it of great eccentricity and revolving in the short period of 16·3 years.

Thus 82 Ceti becomes an important system, and should be carefully watched during the next eight years. Only three other systems revolve more rapidly, namely, β 883 in 5·5 years, κ Pegasi in 11·42, and δ Equulei in 11·45 years.

TELESCOPIC SEEING.—The Lowell Observatory is not of a fixed but of a migratory nature. Like a bird which at some period of the year changes its locality for warmer climes, so this observatory is moved to a region where the air is more suited at that time for better telescopic seeing. Oscillating between Flagstaff, Arizona, and Tacubaya, Mexico, Mr. Lowell is able to take advantage of the periods of good seeing at each of these stations. Both localities satisfy the now well-known geographical and meteorological conditions, and while Flagstaff is rather too far north, bordering on the great cyclonic movement in the north temperate zone in winter, the neighbourhood of the city of Mexico is not affected by this disturbance. The latter station is not, however, found to be ideal, owing to conditions of local topography. What these conditions are will be found stated by Mr. Lowell in his discussion on the capabilities of these two stations (*The Observatory* for November, No. 259).

The well-known observer, Dawes, always used to judge the "goodness" of the night by the size of aperture that could be satisfactorily used; thus he would speak of a one-inch night, three-inch night, up to an eight-inch night, his largest aperture being of eight inches. We are now finding out how accurate this system was, for, owing chiefly to the work of Mr. Douglass, the controversy between large and small apertures seems to be a question of the wave-lengths of the air-waves. An idea of the nature of these small air-waves will be gathered from Dr. See's interesting article in the *Astronomische Nachrichten* (No. 3455), and the diagrams shown illustrate the main conditions for good and bad seeing. These waves vary in different currents from half an inch to several feet. In cases where they move in the same direction and at a great rate the seeing is very bad. With moderate-sized waves moving slowly the definition is generally very fair. Often cross-currents occur, and when fine waves move in all directions the definition is never good, but for cases of very fine seeing only very slight traces of gently moving waves can be discerned. Theoretically for the best seeing there should be no trace of movement at all. Dr. See points out, in another article in the same journal, that the scintillation of the fixed stars can be very easily explained on this wave theory, and the experiments which he has carried out tend to corroborate this view.

THE NOVEMBER METEORS.—At the latter end of this week the earth passes through that stream of meteors which gives us a yearly display on about the 14th of this month. Mr. Denning, who is our chief authority on this subject, and whose admirable memoir on this special swarm should be carefully absorbed, tells us that the morning hours of the 14th should be more especially devoted to their observation, although watches should be commenced a day beforehand and prolonged until the 16th. It is not, however, until the year 1898 that we expect to meet the most dense parts of the swarm, but on former occasions striking displays have been witnessed a year or two previous to the chief one, and this year we hope will be no exception. Let us trust that the weather will not be so unfavourable as it was last November.

THE CONNECTION BETWEEN THE CHARACTERS OF ISOMORPHOUS SALTS AND THE ATOMIC WEIGHT OF THE METALS CONTAINED.

IN order to assist in elucidating the question of the relationship between the chemical composition of solid substances and the nature of the crystals which they are observed to form, both as regards the exterior geometrical configuration and the interior physical character of such crystals, a series of researches were commenced by the author six years ago, having for their immediate object the exact determination of the differences presented by certain well-defined series of isomorphous salts. The differences in question, due to the different nature of the interchangeable chemical elements, belonging to the same family group, which by their mutual replacement give rise to the series, are so small in the case of the morphological constants, that extremely refined methods of investigation are requisite in order to detect and determine them. A large amount of detached data had previously been accumulated in crystallographic literature, but a very small proportion was characterised by the requisite degree of accuracy, and no organised attempt had hitherto been made to investigate any definitely related series of crystallised compounds in a sufficiently detailed and accurate manner. The care and precision demanded will be at once apparent when it is pointed out that the use of slightly impure or imperfect crystals, or the occurrence of slight errors of orientation in grinding out of the crystals the section-plates or prisms requisite for the optical portion of the work, would be sufficient to render the results valueless for the purpose in view. In fact such sources of error have in certain cases been shown by the author during the progress of the work to have led previous observers to conclusions diametrically opposed to the truth.

It was decided to choose, as most suitable for such a study, certain series containing in their different members the three alkali metals potassium, rubidium, and cæsium, on account of the very definite relationship and considerable intervals between their atomic weights, and the extreme electro-positive nature of the group, which latter fact rendered it likely that the differences in question would be here at a maximum. These three metals belong in the strictest sense to the same family group, and their atomic weights are respectively 39, 85·2, and 132·8, the atomic weight of rubidium being thus almost exactly the mean of the values for potassium and cæsium. The particular salts chosen, on account of the general excellence of their crystals, were the normal sulphates and selenates, and the double sulphates and double selenates which these salts form with the sulphates and selenates of magnesium, zinc, iron, manganese, nickel, cobalt, copper, and cadmium. The work on the sulphates, double sulphates, and selenates has at length been completed and presented to the Chemical Society (*Journ. Chem. Soc.*, 1893, 337; 1894, 628; 1896, 344; 1897, 846), and the investigation of the double selenates is now in hand. The choice of the double salts has proved equally as fortunate as that of the simple salts, inasmuch as the influence of the alkali metal is found to be of a vastly preponderating character compared with that of the dyad metal, and hence the eight groups of these salts have furnished so many independent examples of the influence of the atomic weight of the alkali metal. No effort or expense has been spared to render the work absolutely trustworthy and of a final character. The goniometers and other optical instruments employed have been without exception the most accurate that could be constructed, and the observations have been more numerously repeated upon different crystals than has ever before been attempted. Moreover, great care has been bestowed upon the preparation of perfectly pure specimens of the salts, no material being accepted which did not yield absolutely satisfactory results upon both spectroscopic and ordinary gravimetric analysis. Besides goniometrical and optical investigation, the work has included exceptionally careful determinations of the relative density of the salts in the crystallised condition, in order to afford data for the calculation of the volume relationships and of the molecular optical constants. Moreover, the observations have been extended to other than the ordinary temperatures, in order that the deductions shall not be subject to the objection that they may be simply fortuitous for a particular temperature.

Before commencing the optical part of the work attention was concentrated upon devising an instrument which should enable a section-plate (slice), or a 60° prism, to be ground out of

a crystal with precisely such an orientation as might be desired, with respect to the natural faces, and therefore to the morphological axes. For the whole of the optical investigation is carried out by means of such plates and prisms of known orientation, the former being requisite for the establishment of the positions of the principal optical planes, the measurement of the optic axial angle, and the study of the interference phenomena, while the latter are essential for the determination of the three refractive indices. Manifestly, therefore, the accuracy of the optical results depends primarily upon the precision with which the desired orientation of these plates and prisms is attained. Hitherto crystallographers who have investigated the optical properties of the crystals of laboratory preparations, which are so much softer and more friable than mineral crystals, have been content either to employ plates or prisms formed by suitably disposed natural faces of the crystals themselves; or, failing such, to prepare them by grinding the crystals in oil upon a

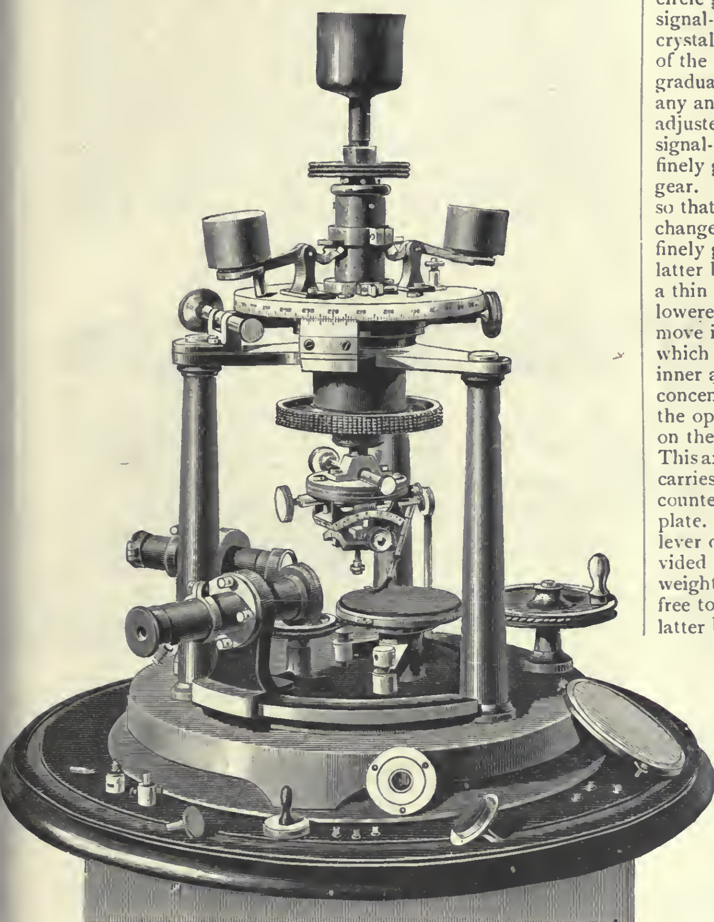


FIG. 1.

ground-glass plate, the crystal being held between the finger and thumb during the process. The difficulty of thus obtaining a plane surface having the desired orientation must be at once apparent, to say nothing of the imminent risk of breaking the crystal. At the best such a method can only be approximate, and it is attended with so much that is troublesome and vexatious that the investigation of a large series of compounds, in the detailed and accurate manner which the author desired, would be impossible.

After much consideration an instrument was eventually devised, and constructed for the author by Messrs. Troughton and Simms, which achieves the desired object in a most satisfactory manner. The author has no hesitation in ascribing the success which has attended the investigation to the admirable manner in which this instrument performs its functions. More than five hundred plates and prisms have already been prepared by its aid and employed in the work; and never once, for instance, has a plate which was desired to be perpendicular to the acute bisectrix of the optic axes failed to exhibit the interference figure by convergent polarised light precisely symmetrical to the centre of the field, as it should be. Moreover, not more than half a dozen crystals have been broken during grinding, and absolutely no plates or prisms have required to be rejected on account of want of accuracy of orientation. Further, what was by the old method a most tedious and disagreeable part of crystallographical work, now becomes one of the most delightful and interesting.

The instrument will be found fully described in the *Transactions* of the Royal Society (1894, A, 887), but a few words here as to the principles of its construction may not be without interest. It is represented, by the kind permission of the Royal Society, in Fig. 1. It may be succinctly termed a grinding goniometer, for it combines an accurate, suspended, horizontal-circle goniometer with a grinding apparatus. The telescope and signal-collimator, together with the circle and the suspended crystal-adjusting apparatus, form the goniometer. The segments of the circular movements of the adjusting apparatus carry finely graduated silver arcs, in order to enable the crystal to be set at any angular position, with respect to any zone of faces previously adjusted parallel to the axis with the aid of the telescope and signal-collimator. The grinding apparatus consists of a small finely ground glass disc, capable of being rotated by hand driving gear. By a simple device the latter is made almost frictionless, so that the disc is rotated almost without effort. Three interchangeable discs are provided, the second being of extremely finely ground glass, and the third of polished glass, these two latter being employed for polishing; all are used lubricated with a thin film of oil. The axis of the instrument is capable of being lowered or raised, so as to bring the crystal to the grinder or remove it, by means of a large milled-headed nut near the summit, which engages with a screw thread on the upper part of the inner axis. In addition to this, however, there is another outer concentric axis capable of vertical movement, intended to enable the operator to regulate the pressure with which the crystal bears on the grinding surface, in order to avoid breaking the crystal. This axis slides in the cylindrical bore of the rotatable cone which carries the circle, and it is capable of being fully or partially counterpoised by two weighted levers carried above the circle plate. It is usually found most convenient to throw the back lever out of gear during the grinding, by raising a screw provided for the purpose on the circle plate, thus leaving half the weight of the axis to bear downwards when the front lever is free to act, and then to more or less curtail the freedom of the latter by gentle manipulation with the left hand, while the right hand is used to rotate the driving pulley of the grinding gear. After a little practice the pressure is nicely regulated almost involuntarily by the left hand in accordance with the "feel" of the grinding, rendering it most unusual to crush the crystal operated upon.

Continuous use of this instrument has proved it to be all that can be desired for use with the crystals of chemical preparations. A somewhat larger instrument has since been constructed for the author, and was described in the *Proceedings* of the Royal Society (57, 324), for use either with chemical preparations or with the harder crystals of minerals; this instrument includes an independent diamond-fed cutting apparatus, and a large selection of metallic and other grinding and polishing laps, so that plates or prisms of even the hardest natural gems can be cut and subsequently ground and polished in an equally satisfactory manner. A duplicate of this instrument is included in the National Collection in the South Kensington Museum.

A further original piece of apparatus, which the author has also found invaluable in the optical part of the work, is a spectroscopic monochromatic illuminator, a description of which will be found in the *Transactions* of the Royal Society (1894, A, 913). It has enabled the author to make observations in every case for six wave-lengths at suitable intervals in the spectrum, and has proved particularly useful inasmuch as each of the series of salts investigated has included at least one member which exhibited exceptional optical properties, generally involving crossed axial plane dispersion of the optic axes, in which instances the command of an illuminator which could be made to yield light of any desired wave-length enabled the phenomena

to be studied with a completeness hitherto unattainable. In brief, the apparatus is a spectroscope with two collimators, the slit of the first being as usual for the entrance of the rays from the source of light, in the author's case the electric arc, while the slit of the second is employed as a selecting slit as in Captain Abney's well-known apparatus. The two optical tubes, however, remain fixed, while the dispersing apparatus, a single large prism of high dispersion, is made to rotate so as to bring the various parts of the spectrum across the selecting slit in turn. The selected ray issuing from the second slit is slightly diffused by a screen of finely ground glass carried in a short sliding tube in front of the slit, which is all that is required in order to flood the whole field of any of the author's observing instruments, such as goniometers, polariscopes, and microscopes, with evenly distributed monochromatic light. The accompanying illustration, Fig. 2, shows, by the kind permission of the Chemical Society, the arrangement as actually used with the gonio-spectrometer in the determination of the refractive indices.

Having thus described the difficulties of the investigation and the measures taken to overcome them, a brief outline of the results attained up to the present will now be given.

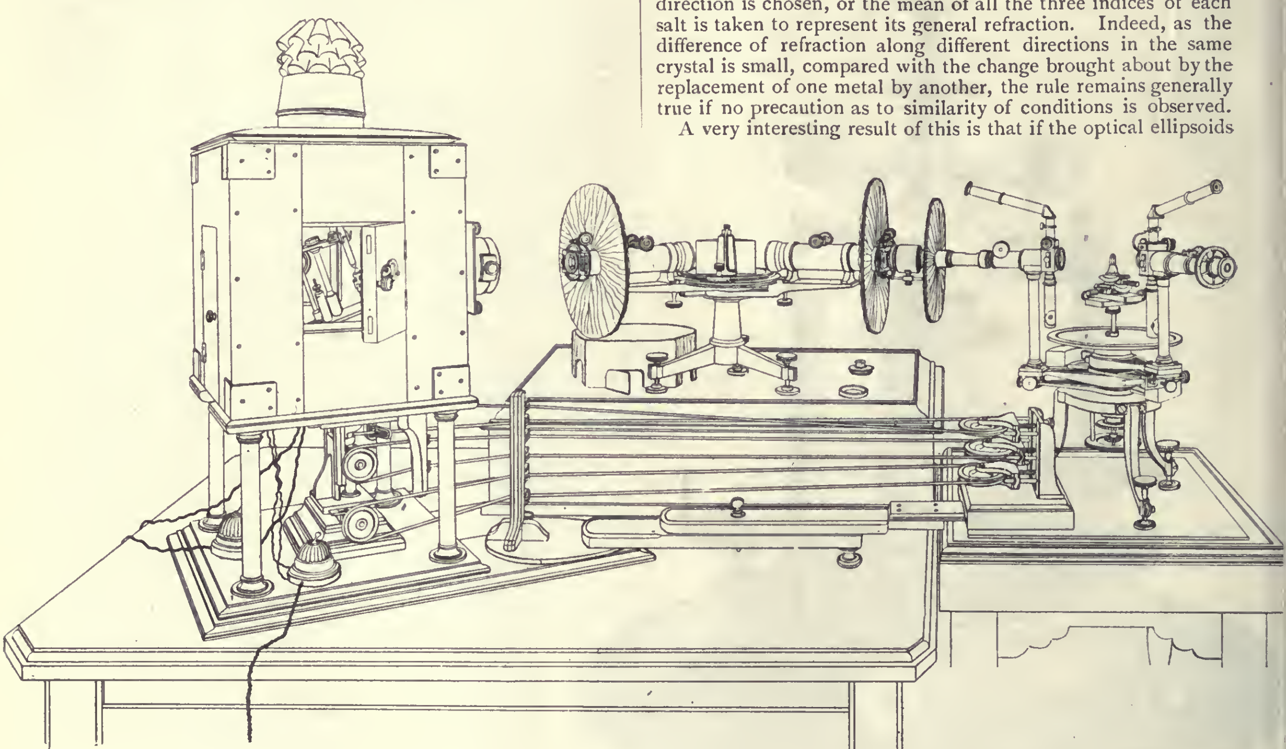


FIG. 2.

The use of the term "isomorphous" is not strictly correct, except in the cases of such series as crystallise in the primary forms of the cubic system, in which, for geometrical reasons, the interfacial angles are always identical. The normal sulphates and selenates of the three alkali metals under consideration crystallise, anhydrous, in the rhombic system, and the double salts of the series $R_2M(SO_4)_2.6H_2O$ in the monoclinic. The same planes are common to all the six simple salts, the replacement of sulphur by its family analogue selenium not effecting any change in this respect; likewise the double sulphates are characterised by planes common to their series. But corresponding interfacial angles on the different members of the same series are not identical, but differ by amounts varying from a few minutes to a couple of degrees. They are much smaller in the simple salt series than in the double salts. The result of elaborate measurements has revealed the fact that, without a single exception, the values of the angles of any rubidium salt are intermediate between those for the corresponding potassium and cæsium salts. There is consequently a progression in the angles of inclination of the crystal faces following the order of progression of the atomic weights of the alkali metals. Moreover, as a natural corollary, there is a corresponding progression in the morphological constants, the axial ratios. Still further, the influence of the nature of the metallic atoms is observed to exercise a curious effect upon the prevailing habits of the crystals. For example, the sulphates and selenates of potassium exhibit preponderating development of the brachypinacoid, the crystals usually being tabular in this direction; on the other hand the cæsium salts are characterised by the prominence of the basal plane, while the rubidium salts are distinguished by a prismatic habit due to the predominance of a brachydomal form intermediate between the two planes just mentioned.

Turning now to the optical properties, it has been found to be a rule without exception that the refractive indices of any rubidium salt are intermediate between those of the corresponding potassium and cæsium salts, and nearer to the former than to the latter, the differences being as one to three. In accordance with the biaxial character of the crystals, each salt has three refractive indices corresponding to the different degrees of facility for the transmission of light along the three rectangular directions of the axes of the optical ellipsoid. In making the comparison, the same result is obtained whether the same direction is chosen, or the mean of all the three indices of each salt is taken to represent its general refraction. Indeed, as the difference of refraction along different directions in the same crystal is small, compared with the change brought about by the replacement of one metal by another, the rule remains generally true if no precaution as to similarity of conditions is observed.

A very interesting result of this is that if the optical ellipsoids of the three rhombic sulphates or selenates are constructed, from the refraction data, about the same origin, using rectangular axial coordinates, which correspond to the mutually identical axes of morphological and optical symmetry, they are found to envelop each other; supposing the ellipsoid to be the optical indicatrix of Fletcher (the optical reference surface now universally employed), the indicatrix for the cæsium salt is the outer one, and that for the potassium salt the innermost, while that corresponding to the rubidium salt lies between the two, without touching either, but nearer to the innermost. In the double sulphate series the indicatrix likewise expands as the atomic weight of the alkali metal rises, but monoclinic symmetry only demands that one of the axes of the indicatrix shall be identical with the single symmetry axis of the system, the other two rectangular axes of the indicatrix being free to move together in the symmetry plane. The expansion of the indicatrix when potassium is replaced by rubidium or the latter by cæsium, is actually found to be accompanied by a rotation for several degrees about the symmetry axis, and the amount of this interesting rotation is more than twice as much for the latter chemical change as it is for the former.

The double refraction is also progressively affected by the replacement of potassium by rubidium and the latter by cæsium, the amount varying inversely as the atomic weight of the metal. Some very remarkable phenomena follow from this rule, owing to the fact that the initial amount of the double refraction in the potassium salt of any series or group is already very small. For a comparatively slight diminution is sufficient to bring it to zero, and even to go further and reverse its sign. As the three refractive indices of any salt are not equidistant from each other in value, and are affected to different extents by the same chemical change, they never in either the rubidium or cæsium salts become reduced to absolute identity at the same time, but become equal in pairs for specific wave-lengths of light and degrees of temperature. When this occurs the crystal becomes for that wave-length and temperature temporarily uniaxial in its optical comportment. The particular salt in which this occurs varies in the different series. In the sulphates it is the rubidium salt, in the selenates the cæsium salt, both at temperatures slightly elevated above the ordinary; in the double sulphates it occurs in cæsium magnesium sulphate and at the ordinary temperature for blue light, while in the other groups of this series the progression never quite reaches the state of equality of two indices. It will be evident that the distribution of the directions corresponding to the α, β and γ indices, and also the optic axial phenomena in convergent polarised light, vary in the three salts of each series or group to a quite extraordinary extent; so much so that without the discovery of this rule, which affords the key to them, the vagaries must have been incomprehensible. For whenever two indices become identical the third is also very nearly so, and consequently the slightest change of wave-length or temperature brings about most drastic changes in the optical phenomena dependent upon the mutual relations of the three. The most striking case is that of cæsium selenate. At the ordinary temperature the sign of double refraction and disposition of the optic axes are already reversed from what they were in potassium and rubidium selenates, and the three indices are so nearly identical that a section plate a centimetre thick is necessary to produce an interference figure in convergent polarised light. On heating gradually to 250°, the sign of double refraction changes twice over, and the optic axes move so rapidly that their acute bisectrix occupies the direction of each of the three morphological axes in turn. That these remarkable phenomena are precisely what are demanded by the rule of progression above enunciated, given the initial optical conditions of the potassium salt, is perhaps the most striking proof of the validity of the rule.

It may be here mentioned that double sulphates of potassium and manganese, and potassium and cadmium, containing six molecules of water, have not yet been obtained, although the corresponding rubidium and cæsium salts are readily formed; yet from the above rule, and others which have been indicated for the other properties, the author has been able to predict the morphological and optical constants which these salts will probably exhibit if ever they are obtained.

The determination of the densities of the crystallised salts has enabled the molecular optical constants to be calculated, with the aid of the formulæ of Lorenz and of Gladstone and Dale. It has been found that they exhibit a similar progressive increase following the increase in the atomic weight of the alkali metal, and that the increase is always greater when cæsium replaces rubidium than when the latter replaces potassium. The molecular refraction for the crystallised state of the sulphates and selenates was also compared with that for the state of solution in water, specific determinations of the density and refraction of highly concentrated solutions of known strength being made for the purpose. It was found that while the values for the two states are approximately the same, there are slight differences, due to the change of state, which observe a distinct progression; for they vary directly as the specific refractive energy and inversely as the atomic weight of the alkali metal. In both series the refraction equivalent of the potassium salt rises by 2½ per cent. when the salt is dissolved in water, and that of the rubidium salt by 1 per cent., while that of the cæsium salt decreases by ½ per cent. This interesting order of the differences clearly demonstrates the quantitative influence of the nature of the alkali metal upon even the smallest details of the physical properties; and the fact that the sign of the differences passes during the progress from positive to negative, indicates the substantial accuracy of the principle enunciated by Dr. Gladstone in 1868 that "the refraction equivalent of a solution is the sum of the refraction equivalents of the solvent and the substance dissolved," by the application of which principle the calculations for the state of solution were made.

The molecular volumes of the members of each series likewise exhibit the order of the atomic weights of the alkali metals, but the progression again proceeds more rapidly than in simple arithmetical proportion to the latter. A point of particular interest was elicited with respect to the volumes of the double sulphates, which throws a strong light upon the nature of those salts. It was found that the volume of the alkali sulphate is the same in the double salt as it is for the simple salt itself, that is to say, the simple alkali sulphate enters into the structure of the double salt without suffering any contraction in volume. This fact, contrasted with the very large contraction which accompanies the chemical union of the elementary constituents of the simple sulphates, negatives the possibility of chemical combination of the molecular constituents of the double salts. This, together with other facts which the investigation has brought to light, has led to the important conclusion that the composition of these double salts is simply a result of the aggregation of the molecular constituents in a particular type of homogeneous structure, in which they find stablest equilibrium, the very nature of this structure ensuring that the component simple molecules are always present in the same, the observed, proportion. The elucidation and definition of all the possible types of homogeneous structures have recently been elaborately worked out by Federow on the continent, and Barlow in this country, and the precise correspondence between the possible types of homogeneous structures and the observed varieties of crystal symmetry is now established beyond all doubt. The author has been able to indicate, moreover, the particular member of Barlow's classification corresponding to both the simple and double salt series.

The conclusion just referred to, regarding the nature of the double sulphates, taken in connection with other facts which the author has established, leads to a further one of a still more far-reaching character, namely, that the units of a homogeneous crystal structure are the simple chemical molecules themselves, and that the current assumption that the crystal unit is a more or less complex aggregation of chemical molecules is quite unnecessary and in general erroneous. This conclusion is further strongly supported by some recent work of Fock, on the solubilities of mixed crystals, based upon the theory of solid solutions.

Before leaving this interesting subject it should be mentioned that a method has been found, by combining the molecular volume with the morphological axial ratios, of determining the relative distances apart of the centres of contiguous chemical molecules of the sulphates and selenates, and of contiguous groups of the eight component chemical molecules of the double sulphates, each such group corresponding to the generic formula $R_2SO_4.MSO_4.6H_2O$. A comparison of these "distance ratios" shows that the replacement of potassium by rubidium, and of the latter by cæsium, is accompanied by a progressive increase in the separation of the structural units or groups of units in every direction, corresponding to the progress of the atomic weight of the alkali metal, and that the latter replacement always gives rise to a greater extension of the structure than the former.

In conclusion, the net result of the investigation has been to show that the whole of the morphological and physical properties of the crystals of each of these isomorphous series exhibit progressive variations, which follow the order of progression of the atomic weights of the alkali metals which the salts contain. Hence it may be said that these variations are functions of the atomic weight of the alkali metal, and it has been shown that the function is usually one which involves higher powers than the first. Of course atomic weight is only one of the numerous properties of an element, but it is doubtless the most convenient reference constant that could be chosen to express fundamentally the difference in the essential nature of the atoms of different elements. It is this difference in essential nature which gives rise to the rules which have been brought to light by the investigation; and the author desires to make it quite clear that atomic weight is merely employed as the basis of reference because it is the aptest expression of such difference, and not because of any virtue in atomic weight *per se*. The fact that the rules are equally applicable to series so widely different as the rhombic sulphates and selenates and the monoclinic double salts, appears to indicate their application to isomorphous series

in general. Hence the author concluded his last communication to the Chemical Society in the following words: "The difference in the nature of the elements of the same family group which is manifested in their regularly varying atomic weights, is also expressed in the similarly regular variation of the characters of the crystals of an isomorphous series of salts of which these elements are the interchangeable constituents."

A. E. TUTTON.

THE JACKSON-HARMSWORTH ARCTIC EXPEDITION.

THE first meeting of the present session of the Royal Geographical Society took place at the Queen's Hall, Langham Place, on Monday night last, when Mr. Frederick G. Jackson lectured on the expedition led by himself to the Arctic regions. For the following abridged account of the lecture we are indebted to the *Times*:—

It was in August 1873 that the land afterwards known as Franz Josef Land was first accidentally discovered by the Austro-Hungarian expedition, under the leadership of Weyprecht and Payer. The following spring Payer made three journeys up and in the neighbourhood of what he then named Austria Sound. Arctic authorities advocated the route to the north suggested by Payer's impression that there was land still further to the north in and beyond the eighty-third degree, and land to the north-west reaching almost as far, and it was on Payer's observations that Mr. Jackson formulated his plans in the latter end of 1892. Unfortunately his expectations were fated to disappointment by the non-extension of the land to the north. His plans embraced not only an advance in a northerly direction, but the mapping-in of the coast-lines of Franz Josef Land, a thorough examination of that country, in taking scientific observations, and making collections generally. Those plans they had been able to carry out; and scientific observations had been carried on uninterruptedly for three years. They had also practically completed the map of Franz Josef Land, and settled the Gillis Land question. For some time the sinews of war were conspicuous by their absence, and little encouragement was given, but eventually Mr. Alfred Harmsworth generously offered to provide the necessary funds for the proposed expedition. They left the Thames on July 12, 1894, in the steam yacht *Windward*, calling at Archangel. Then they proceeded east, skirting the northern shores of Kolguev Island to Kharborova, a Samoyed settlement on the Yugor Straits, to take on board their thirty dogs and some fresh reindeer meat. They then steamed north through the Barents Sea, making for Bell Island, Franz Josef Land. The mass of islands of which Franz Josef Land was comprised consisted of high glacier-land rising to 2000 feet, covered with an ice-cap some hundreds of feet in thickness, and fronted along the shore by high perpendicular glacier faces from 30 feet to 80 feet in height. At rare intervals high black basaltic rocks jutted out of the ice near the shore, forming the only conspicuous landmarks. In front of these rocks the broken-down débris from the cliffs had formed a plateau, or shore, upon which a certain amount of stunted Arctic vegetation existed. Here might be found a few poppies, saxifrages, mosses, lichens, &c. Everywhere else, with the exception of a few low islands, the ice-sheet overran everything. Thick mists generally overhung this land; violent gales were frequent, combined with heavily falling and driving snow. Finding no suitable site for their hut, they returned to Cape Flora, a high basaltic cape 1400 feet high, beneath which they pitched their camp, as being the most favourable spot they had yet seen, one of the strongest inducements being the presence of a large loomery there in the high rocks, and the known presence of bears and walruses throughout the year. This they reached on September 8. They at once set to work to shoot bears and walruses for the winter, and to put up their log hut, which was named "Elmwood," and to make themselves as comfortable as circumstances would allow. On the return of the sun, about the middle of February, they got ready to start, and on March 9 Mr. Armitage and he took a preliminary journey with the object of making a depôt of provisions to the north and of ascertaining the character of the travelling in that direction. In the beginning of April they got under way with three ponies and a number of sledges, being accompanied for the first week by Dr. Koettlitz and young Hayward with one pony and sledges. Soon after rounding Dundee Point they discovered that the existing maps were not quite in accordance with fact. To the northward lay floe ice where land had been mapped in; and it was not till they reached the latitude of Point Arthur that they could discern land to the westward. To the south-west appeared open ocean. The weather now became very bad, and they were frequently confined to their tent for days together. Constant gales and driving snow impeded their advance, and the floe ice itself became very unstable with water in the deeper layers of the snow, so that they were frequently wading about in slush above their knees. They, however, pushed on. Richthofen Peak could nowhere be discerned, and no hill worthy of the name of mountain could be seen in any direction, although they were within half a mile of its supposed site. On April 30 they rounded Cape Fisher, and to the north appeared a low island, which in the distance had rather a volcanic appearance, owing to a cup-shaped elevation upon it. On May 1 they rounded Cape M'Clintock, a low weathered cape of columnar basalt, projecting out of the ice-clad land behind. A striking feature of this rock was a pillar of columnar basalt standing up in front of it. Thus it was in April 1895 that they discovered the Queen Victoria Sea, which he named after her Majesty. They reached a point 81° 20′ N. They carefully mapped in the whole coast-line, although the weather was exceedingly unsuitable for taking bearings. On May 4 they started back in a strong wind, dense mist, and driving snow, returning by the same route as they had come up. The difficulties of the floes daily increased. They had constantly to haul the ponies out of the snow morasses with ropes round their necks. They would then go for a few yards further and would flounder in again. They frequently had to take the sledges on themselves, leading the ponies through especially bad places, and had to go over the same ground thirteen times to effect this. On their return journey they got a view of the land to the north-west, which appeared to consist of islands. They returned again round the cape that he had named Cape Richthofen. thus giving themselves an opportunity of discovering the whereabouts of Richthofen Peak, if such existed; but they again failed to see any sign of such a hill in any direction. On May 12 they reached their hut at Cape Flora, getting the ponies back in the nick of time. After their return they were busy with botanical, geological, and other examinations, and in fitting up their whaleboat, the *Mary Harmsworth*, for a journey round the south-west coast as soon as the *Windward* should break loose from her winter quarters and depart for home. This she did on July 3, after being cut out of the ice. To the southward there appeared to be little ice, and from an altitude of over 1400 feet little more than open sea could be discerned. The other expeditions made by Mr. Jackson during his stay were described, and the lecturer concluded by saying that, so far from viewing Franz Josef Land as a favourable route to the Pole, his experiences now led him to believe it to be one of the worst; and although he had, in common with other Arctic explorers, the greatest desire to stand upon that mathematical point, still he had no sympathy with an attempt to reach the Pole as a mere athletic feat alone, but considered that geographical and other scientific work should always be included in the plan.

REPORT ON TECHNOLOGICAL EXAMINATIONS.

THE report on the work of the Examinations Department of the City and Guilds of London Institute for the session 1896-97 has just reached us, and is as usual a very business-like and interesting publication. We make a few extracts from it.

There has been a marked development in the work of the Examinations Department of the Institute during the past Session, as shown not only in the larger number of classes in Technology registered by the Institute, but also in the increase in the number of students in attendance at such classes, and of candidates for examination. This development is due to the further provision of facilities for technical instruction, and also to the fuller recognition of its value and importance.

The report before us shows that the Institute has endeavoured in various ways to assist this forward movement

Since the Technological Examinations were first undertaken by the Institute, the organisation of technical instruction has been greatly promoted by the Educational Committees of County Councils, with which the Institute has established close relations; and many of the improvements, which have been introduced into its schemes of instruction and examination, have been due

to the suggestions of the organising secretaries of those committees.

In London, through its representation on the Technical Education Board of the London County Council and on the London Polytechnic Council, the Institute has taken a large share in the direction and organisation of the educational work of the Polytechnic Institutions; and in accordance with the original scheme of the Charity Commissioners for the administration of those bodies, the examinations of the Institute have been generally adopted, and the instruction given in those Institutions, although in no way unduly subordinated to examination influences, has been legitimately, and, it is believed, usefully, directed by the Institute's requirements.

During the session under review the number of students in attendance at the classes registered by the Institute was 32,566, as against 29,494 in the previous year, and the number of candidates' papers examined was 12,868, as against 12,099.

To enable the Institute to adapt its schemes of instruction to local needs and to the changing requirements of different trades, and to make its examinations a true test of the technical knowledge and ability of the artisan students who have been trained in its registered classes, frequent changes are made in its syllabuses of instruction, and tests of workmanship, wherever practicable, are made a part of the examination. Several alterations have been made in the programme of instruction and examination for the session 1897-98, to some of which we draw attention. Thus, in the syllabuses of textile subjects, important changes have been introduced.

Reference was made in last year's report to a discussion by a committee of experts in Lancashire of the conditions of examination in cotton weaving. The report of that committee was received by the Institute early in the session, and subsequently a conference was held in London of representatives of the Institute, the Institute's examiners and inspector, and delegates from the Technical Instruction Committee of the Manchester County Council. As a result of that conference, it was proposed that a new syllabus should be prepared in several of the weaving subjects to cover a period of three years, and that the full certificate should be granted to those students only who complete the three years' course of study. It was also considered advisable that candidates, before entering upon their first year's course of technical instruction, should pass a preliminary examination in the subjects of arithmetic, drawing, and elementary physics, in their special application to the technology of spinning and weaving. The representatives of the Union of Lancashire and Cheshire Institutes, having undertaken to prepare and submit for approval to the Committee of the Institute a syllabus of instruction for this preliminary examination, the Institute decided, after carefully considering the syllabus, to accept the certificate of the Union in lieu of the certificates of the Science and Art Department, previously required to qualify for a full technological certificate. New syllabuses were accordingly prepared in cotton spinning and weaving, in wool and worsted spinning and weaving, and also in jute spinning and weaving; and these syllabuses, after being modified by different experts to whom they were submitted, were finally adopted by the Institute, and have been inserted in the Programme. To obtain a certificate in the ordinary grade of either branch of calico or cloth manufacture, it will now be necessary that the student, unless specially exempted, should go through a two years' course of study and pass an examination at the end of each year's work.

In the subject of iron and steel manufacture, a new syllabus has been written; and with the view of adapting the examination to the requirements of students working in different parts of the country, a large number of questions will be given, covering the different sections into which the syllabus has been divided, and candidates will be at liberty to select those questions bearing upon the practice of the trade in the district in which they work.

It has been thought desirable to limit the scope of the examination in the electro-metallurgy to the principles underlying the electro-deposition of metals, and in order to bring the instruction into closer touch with the requirements of students engaged in the manufacture of electro-plated goods, the syllabus of examination has been modified, and the title of the subject has been changed into that of "Electro-Plating and Deposition."

The syllabus in mine surveying has been re-written with the view of making the instruction and examination more distinctly technical than hitherto. Questions will be set involving a knowledge of logarithms and trigonometry, and of the application of trigonometry to problems in mine surveying; but the questions in pure mathematics, which previously formed a part of the examination, will be omitted.

The report, in addition to giving particulars as to the various examinations which took place in connection with the session, contains extracts from statements made by the examiners concerning the general character of the work examined, which should prove useful to both teachers and students.

EXPERIMENTAL MORPHOLOGY.[1]

IN looking at the progress which has been made in the study of plant morphology, I have been as much impressed with the different attitudes of mind toward the subject during the past 150 years as by the advance which has taken place in methods of study, as well as the important acquisitions to botanical science. These different view points have coincided to some extent with distinct periods of time. What Sachs in his "History of Botany" calls the "new morphology" was ushered in near the middle of the present century by von Mohl's researches in anatomy, by Naegeli's investigations of the cell, and Schleiden's history of the development of the flower. The leading idea in the study of morphology during this period was the inductive method for the purpose of discerning fundamental principles and laws, not simply the establishment of individual facts, which was especially characteristic of the earlier period when the dogma of the constancy of species prevailed.

The work of the "herbalists" had paved the way for the more logical study of plant members by increasing a knowledge of species, though their work speedily degenerated into mere collections of material and tabulations of species with inadequate descriptions. Later the advocates of metamorphosis and spiral growth had given an impetus more to the study of nature, though diluted with much poetry and too largely subservient to the imagination, and to preconceived or idealistic notions.

But it was reserved for Hoffmeister (1859), whose work followed within three decades of the beginnings of this period, to add to the inductive method of research, as now laid down, the comparative method; and extending his researches down into the Pteridophyta and Bryophyta, he not only established for these groups facts in sexuality which Camerarius and Robert Brown had done for the Spermatophyta, but he did it in a far superior manner. He thus laid the foundation for our present conceptions of the comparative morphology of plants. Naegeli's investigations of the cell had emphasised the importance of its study in development, and now the relation of cell growth to the form of plant members was carried to a high degree, and it was shown how dependent the form of the plant was on the growth of the apical cell in the Pteridophyta and Bryophyta, though later researches have modified this view; and how necessary a knowledge of the sequence of cell division was to an understanding of homologies and relationships. Thus in developmental and comparative studies, morphology has been placed on a broader and more natural basis, and the homologies and relationships of organs between the lower and higher plants are better understood.

But the growth of comparative morphology has been accompanied by the interpretation of structures usually from a teleological standpoint, and in many cases with the innate propensity of the mind to look at nature in the light of the old idealistic theories of metamorphosis.

I wish now to inquire if we have not recently entered upon a new period in our study of comparative morphology. There are many important questions which comparative studies of development under natural or normal conditions alone, cannot afford a sufficient number of data. We are constantly confronted with the problems of the interpretation of structure and form, not only as to how it stands in relation to structures in other plants, which we deal with in comparative morphology, but the meaning of the structure or form itself, and in relation to the other structures of the organism, in relation to the environment, and in relation to the past. This must be met by an inquiry on our part as to why the structure or form is what it is, and what are the conditions which influence it. This we are

[1] Address delivered before Section G (Botany) of the American Association f r the Advancement of Science, at Detroit, by Prof. G. F. Atkinson. (Numerous bibliographical references were given in the course of the address, but these have been omitted.)

accustomed to do by *experiment*, and it begins to appear that our final judgments upon many questions of morphology, especially those which relate to variation, homology, &c., must be formed after the evidence is obtained in this higher trial court, that of *experimental morphology*. While experimental morphology as a designation of one branch of research in plants, or as a distinct and important field of study, is not yet fully taken cognisance of by botanists, we have only to consult our recent literature to find evidence that this great and little explored field has already been entered upon.

Experimental methods of research in the study of plants have been in vogue for some time, but chiefly by plant physiologists and largely from the standpoint of the physical and chemical activities of the plant, as well as those phases of nutrition and irritability, and of histologic structure, which relate largely to the life processes of the plant, and in which the physiologist is therefore mainly interested. In recent years there has been a tendency in physiological research to limit the special scope of these investigations to those subjects of a physical and chemical nature. At the same time the study of the structure and behaviour of protoplasm is coming to be regarded as a morphological one, and while experimental methods of research applied to the morphology of protoplasm and the cell is comparatively new, there is already a considerable literature on the subject even upon the side of plant organisms. While certain of the phenomena of irritability and growth are closely related to the physics of plant life, they are essentially morphologic; and it is here especially that we have a voluminous literature based strictly on the inductions gained by experimentation, and for which we have chiefly to thank the physiologist.

If we were to write the full history of experimental morphology in its broadest aspect, we could not omit these important experimental researches on the lower plants in determining the ontogeny of polymorphic species of algæ and fungi which were so ably begun by De Bary, Tulasne, Pringsheim, and others, and carried on by a host of European and American botanists. The tone which these investigations gave to taxonomic botany has been felt in the study of the higher plants, by using to some extent the opportunities at botanic gardens where plants of a group may be grown under similar conditions for comparison, and in the establishment of alpine, subalpine and tropical stations for the purpose of studying the influence of climate on the form and variations of plants, and in studying the effect of varying external conditions.

While experimental morphology in its broadest sense also includes in its domain cellular morphology, and the changes resulting from the directive or taxic forces accompanying growth, it is not these phases of morphology with which I wish to deal here.

The question is rather that of experimental morphology as applied to the interpretation of the modes of progress followed by members and organs in attaining their morphologic individuality, in the tracing of homologies, in the relation of members associated by antagonistic or correlative forces, the dependence of diversity of function in homologous members on external and internal forces, as well as the causes which determine the character of certain paternal or maternal structures. I shall deal more especially with the experimental evidence touching the relation of the members of the plant which has been represented under the concept of the leaf, as expressed in the metamorphosis theory of the idealistic morphology. The poetry and mystery of the plant world, which was so beautifully set forth in the writings of Goethe and A. Braun, are interesting and entrancing, and poetic communication with nature is elevating to our ethical and spiritual natures. But fancy or poetry cannot guide us safely to the court of inquiry. We must sometimes lay these instincts aside and deal with nature in a cold, experimental, calculating spirit.

The beginnings of experimental morphology were made about one century ago, when Knight, celebrated also for the impulse which he gave to experimental physiology, performed some very simple experiments on the potato plant. The underground shoots and tubers had been called roots until Hunter pointed out the fact that they were similar to stems. Knight tested the matter by experiment, and demonstrated that the tubers and underground stems could be made to grow into aerial leafy shoots. This he regarded as indicating a compensation of growth, and he thought, further, that a compensation of growth could be shown to exist between the production of tubers and flowers on the potato plant. He reasoned that by the prevention of the development of the tubers the plant might be made to bloom. An early sort of potato was selected, one which rarely or never set flowers, and the shoots were potted with the earth well heaped up into a mound around the end of the shoot. When growth was well started, the soil was washed away from the shoot and the upper part of the roots, so that the plant was only connected with the soil by the roots. The tubers were prevented from growing, and numbers of flowers were formed. This result he also looked upon as indicating a compensation of growth between the flowers and tubers.

While we recognise Knight's experiments as of great importance, yet he erred in his interpretation of the results of this supposed correlation between the tubers and flowers, as Vöehting (1887, 1895) has shown. By repeating Knight's experiment, and also by growing shoots so that tubers would be prevented from developing, while at the same time the roots would be protected, flowers were obtained in the first case, while they were not in the second; so that the compensation of growth, or correlation of growth, here exists between the vegetative portion of the plant and the flowers, instead of between the production of tubers and flowers, as Knight supposed.

The theory of metamorphosis as expressed by Goethe and A. Braun, and applied to to the leaf, regarded the leaf as a *concept* or *idea*. As Goebel points out, Braun did not look upon any one form as the typical one, which through transformation had developed the various leaf forms; but each one represented a wave in the march of the successive billows of a metamorphosis, the shoot manifesting successive repetitions or renewals of growth each season, presenting in order the "niederblätter, laublätter, hochblätter, kelchblätter, blumenblätter, staubblätter, fruchtblätter." Though it had been since suggested from time to time, as Goebel remarks, that the foliage leaf must be regarded as the original one from which all the other forms had arisen (at that time Goebel did not think this the correct view). No research, he says, had been carried on, not even in a single case, to determine this point. Goebel plainly showed, in the case of *Prunus padus*, that axillary buds, which under normal conditions were formed one year with several bud scales, could be made by artificial treatment to develop during the first year. This he accomplished by removing all the leaves from small trees in April, and in some cases also cutting away the terminal shoot. In these cases the axillary shoots, instead of developing buds which remained dormant for one year, as in normal cases, at once began to grow and developed well-formed shoots. Instead of the usual number of bud scales, there were first two stipule-like outgrowths, and then fully expanded leaves were formed; so that in this case, he says, the metamorphosis of the leaf to bud scales was prevented. For this relation of bud scales to foliage leaves, Goebel proposed the term "correlation of growth." In the case of *Vicia faba*, removal of the lamina of the leaf of seedlings, when it was very young, caused the stipules to attain a large size, and to perform the function of the assimilating leaf. He points out that experimentation aids us in interpreting certain morphological phenomena which otherwise might remain obscure. He cites the occasional occurrence ("Moquin-Tandon") in the open of enlarged stipules of this plant, which his experiment aids in interpreting. In the case of *Lathyrus aphaca*, the stipules are large and leaf-like, while the part which corresponds to the lamina of the leaf is in the form of a tendril, the correlation processes here having brought about the enlargement of the stipules as the lamina of the leaf became adapted to another function. Kronfeld repeated some of Goebel's experiments, obtaining the same results, and extended them to other plants (*Pirus malus* and *Pisum sativum*), while negative results attended some other experiments. Hildebrand, in some experiments on seedlings and cuttings, found that external influences affected the leaves, and in some cases, where the cotyledons were cut, foliage leaves appeared in place of the usual bud scales. In *Oxalis rubella*, removal of the foliage leaf, which appears after the cotyledons, caused the first of the bulb scales, which normally appear following the foliage leaf, to expand into a foliage leaf.

In some experiments on the influence of light on the form of the leaves, Goebel has obtained some interesting results. Plants of *Campanula rotundifolia* were used. In this species the lower leaves are petioled and possess broadly-expanded, heart-shaped laminæ, while the upper leaves are narrow and sessile, with intergrading forms. Plants in different stages of growth were

placed in a poorly lighted room. Young plants which had only the round leaves, under these conditions continued to develop only this form of leaf, while older plants which had both kinds of leaves when the experiment was started, now developed on the new growth of the shoot the round-leaved form. In the case of plants on which the flower shoot had already developed, side shoots with the round leaves were formed.

Excluding the possibility of other conditions having an influence here, the changes in the form of the leaves have been shown to be due to a varying intensity of light. The situation of the plants in the open favour this view, since the leaves near the ground in these places are not so well lighted as the leaves higher up on the stem. In this case the effect of dampness is not taken into account by the experimenter, and since dampness does have an influence on the size of the leaf, it would seem that it might be at least one of the factors here. An attempt was now made to prevent the development of the round leaves on the young seedlings. For this purpose the plants were kept under the influence of strong and continuous lighting. The round leaves were nevertheless developed in the early stage, an indication that this form of the leaf on the seedling has become fixed and is hereditary.

Hering found that enclosing the larger cotyledon of streptocarpus in a plaster cast so as to check the growth, the smaller and usually fugacious one grew to the size of the large one, provided the experiment was started before the small one was too old. Amputation of the large cotyledon gave the same results.

Other experimenters have directed their attention to the effect of light and gravity on the arrangement of the leaves on the stem, as well as to the effect of light on the length of the petiole and breadth of the lamina. Among these may be mentioned the work of Weisse, Rosenvinge, and others.

Goebel has shown experimentally that dampness is also one of the external influences which can change the character of xerophyllous leaves. A New Zealand species of Veronica of xerophyllous habit and scaly appressed leaves, in the seedling stage has spreading leaves with a broad lamina. Older plants can be forced into this condition in which the leaves are expanded, by growing them in a moist vessel. Gain, Askehasy, and others have shown that dampness or dryness has an important influence in determining the character of the leaves.

The results of the experiments in showing the relation of the leaf to the bud scales, Goebel regards as evidence that the foliage leaf is the original form of the two, and that the bud scale is a modification of it.

Treub conducted some interesting experiments for the purpose of determining the homology of the pappus of the Compositæ. Gall-insects were employed to stimulate the pappus of *Hieracium umbellatum*, and it was made to grow into a normal calyx with five lobes. A recent letter from Prof. Treub states that he later repeated these experiments with other species of Compositæ with like results, but the work was not published. Kny found, in seedlings and cuttings which he experimented with, that while there was still stored food available for the roots and shoots, there was little if any dependence of one upon the other. Hering comes to somewhat different conclusions as a result of his experiments, finding that in some cases there was a slight increase of growth, while in others growth of the one was reciprocally retarded when either the other was checked in development. Numerous cases of horticultural practice in pollination of fruits shows that the form and size of the fruit, and of the adjacent parts, as well as the longer or shorter period of existence of the floral envelopes, can be influenced by pollination.

The investigations carried on by Klebs in the conjugation of Spirogyra suggest how experimentation of this kind may be utilised to determine questions which in special cases cannot be arrived at easily by direct investigation. If threads of *Spirogyra varians* which are ready for conjugation are brought into a 0·5 per cent. solution of agar-agar, in such a way that nearly parallel threads lie at a varying distance in their windings, where they are within certain limits, the conjugation tubes are developed and the zygospores are formed. But where the threads lie at too great a distance for the influences to be exerted, the cells remain sterile, and no conjugation tubes are developed. If now these threads be brought into a nutrient solution, the cells which were compelled to remain sterile grow and develop into new threads, *i.e.* they take on the vegetative, though they are fully prepared for the sexual function. Strasburger has pointed out that this may be taken as excluding the possibility of there being a reducing division of the chromosomes during the maturing of the sexual cells, a process which takes place in animals, and that the behaviour of Spirogyra in this respect agrees with what is known to take place in the higher plants, viz. that the reduction process is not one which is concerned in the maturity of the gametes. The same could be said of Polyphagus, in which Nowakowski found that before the zygospore was completely formed the protoplasm moved out and formed a new sporangium.

In *Protosiphon botryoides* Klebs was also able to compel the parthenogenetic development of the motile gametes, and the same thing was observed in the case of the gametes of Ulothrix. If we are justified in interpreting this phenomenon as Strasburger suggests, the evidence which Raciborski gives as a result of his experiments with *Basidiobolus ranarum* would support the idea that there is no reducing division in the chromosomes before the formation of the nuclei of the gametes. Raciborski found that the young zygospores of this species, in old nutrient medium where the fusion of the plasma contents had taken place, but before the nuclei had fused, if they were placed in a fresh nutrient medium the fusion of the nuclei was prevented, and vegetative growth took place, forming a hypha which possessed two nuclei—the paternal one and the maternal one. Raciborski interprets Eidam's study of the nuclear division prior to the copulation of the gametes as showing that the reducing division takes place here as in the maturation of the sexual cells of animals, and looks upon the premature germination of the zygospore as showing that a paternal and maternal nucleus possesses the full peculiarities of a normal vegetative one. However, we are not justified in claiming a reducing division for the nuclei preceding the formation of the gametes in Basidiobolus from the work of Eidam, since he was not able to obtain sufficiently clear figures of the division to determine definitely how many divisions took place, to say nothing of the lack of definite information as to the number of chromosomes. Fairchild has recently studied more carefully the nuclear division, but, on account of the large number of the chromosomes, was not able to determine whether a reduction takes place. He points out, as others have done, the similarity in the process of the formation of the conjugating cells of Basidiobolus and Mougeotia among the Mesocarpeæ, and to these there might be added the case of Sirogonium, in which the paternal cell just prior to copulation undergoes division. The division of the copulation cells in Basidiobolus, Mougeotia, Sirogonium, &c., suggest at least some sort of preparatory act; but whether this is for the purpose of a quantitative reduction of the kinoplasm, as Strasburger thinks sometimes takes place, or is a real reduction in the number of the chromosomes, must be determined by further study, so that the bearings of these experiments on the question of a reducing division must for the time be held in reserve.

One of the very interesting fields for experimental investigation is that upon the correlation processes which govern morphology of the sporophylls (stamens and pistils) of the Spermatophyta. One of the controlling influences seems to be that of nutrition, and in this respect there is some comparison to be made with the correlative processes which govern the determination of sex in plants. Among the ferns and some others of the Pteridophyta a number of experiments have been carried on by Prantl, Bauke, Heim, Buchtien and others to determine the conditions which influence the development of antheridia and archegonia. Prantl found that on the prothallia of the ferns grown in solutions lacking nitrogen there was no meristem, and consequently no archegonia, while antheridia were developed; but if the prothallia were changed to solutions containing nitrogen, meristem and archegonia were developed. All the experiments agree in respect to nutrition; with scanty nutrition antheridia only were developed, while with abundant nutriment archegonia were also developed. Heim studied the influence of light, and found that fern prothallia grow best with light of 20 to 25 per cent. Exclusion of the ultra-violet rays does not affect the development of the sexual organs. He argues from this that the ultra-violet rays are not concerned in the elaboration of the material for flower production, as Sachs as suggested. In yellow light the prothallia grew little in breadth; they also grew upward, so that few of the rhizoids could reach the substratum. Antheridia were here very numerous. After seven months these prothallia were changed to normal light, and in four months afterwards archegonia were developed.

Among the algæ Klebs has experimented especially with

Vaucheria, such species as *V. repens* and *V. ornithocephala*, where the antheridia and oogonia are developed near each other on the same thread. With weak light, especially artificial light, the oogonium begins first to degenerate. He never succeeded in suppressing the antheridia and at the same time to produce oogonia.

High temperature, low air pressure or weak light, tend to suppress the oogonia, and at the same time the antheridia may increase so that the number in a group is quite large, while the oogonium degenerates or develops vegetatively. Klebs concludes from his experiments that the causes which lie at the bottom of the origin of sex in *Vaucheria*, as in other organisms, are shrouded in the deepest mystery.

In the higher plants a number of experiments have been carried on for the purpose of learning the conditions which govern the production of staminate and pistillate flowers, or in other words the two kinds of sporophylls. From numerous empirical observations on diœcious Spermatophyta, the inference has generally been drawn that nutrition bears an important relation to the development of the staminate and pistillate flowers; that scanty nutrition produces a preponderance of staminate plants, while an abundance of nutrition produces a preponderance of pistillate plants. For a period covering three decades several investigators have dealt with this question experimentally, notably K. Müller, Haberlandt, and Hoffmann. These experiments in general give some support to the inferences from observation, yet the results indicate that other influences are also at work, for the ratios of preponderance either way are not large enough to argue for this influence alone. In a majority of cases thick sowings, which in reality correspond to scanty nutrition, tend to produce staminate plants; while thin sowings tend to produce pistillate plants. In the case of the hemp (*Cannabis sativa*), Hoffmann found that these conditions had practically no influence. He suggests that the character of each may have been fixed during the development of the seed, or even that it may be due to late or early fecundation.

In monœcious plants it has often been observed that pistillate flowers change to staminate ones and *vice versâ*, and in diœcious plants pistillate ones sometimes are observed to change to staminate ones (the hemp for example, see Nagel, 1879). K. Müller states that by scanty nutrition the pistillate flowers of Zeamays can be reduced to staminate ones.

Among the pines what are called androgynous cones have in some instances been observed. In *Pinus rigida* and *P. thunbergii*, for example, they occur (Masters). Natsuda has described in the case of *Pinus densiflora* of Japan, pistillate and androgynous flowers which developed in place of the staminate flowers, and conversely staminate and androgynous flowers in place of pistillate ones. Fujii has observed that where the pistillate or androgynous flowers of *Pinus densiflora* occur in place of the staminate ones, they are usually limited to the long shoots which are developed from the short ones of the previous year. The proximity of those transformed short shoots (Kurztrieb) to injuries of the long ones, suggested that the cutting away of the long ones might induce the short ones to develop into long ones, and the flowers which were in the position for staminate ones to become pistillate.

Fujii says, "In fact, the injuries producing such effect are frequently given by Japanese gardeners to the shoots of the year of *Pinus densiflora* in their operations of annual pollarding. But the 'Langtrieb' which is transformed from a 'Kurztrieb' of the last year does not necessarily bear female of hermaphrodite flowers in the positions of male flowers." To determine the influence of pollarding of the shoots he carried on experiments on this pine in the spring of 1895. He pollarded the shoots, so that, as he terms it, to induce the nourishment to be employed in the development of the flowers and short shoots near the seat of injury. In other cases one or two shoots were preserved while all the adjacent shoots of last year's growth at the top of the branch were removed, and, further, both of these processes were combined. Out of the forty-five branches experimented on, and on which there were no signs of previous injury, there were nine pistillate or androgynous flowers in place of staminate ones; in twenty-one branches with signs of previous injury, five were transformed, while in 2283 not experimented on, and with no signs of previous injury, only seven were transformed. Such abnormal flowers, then, are due largely to the injuries upon the adjacent shoots, and, Fujii thinks, largely to the increased amount of nourishment which is conveyed to them as a result of this.

From the experiments thus far conducted upon the determination of sex in plants or upon the determination of staminate or pistillate members of the flower, nutrition has at least some influence in building up the nourishing tissue for the two different organs or members. This can in part be explained on the ground that antheridia and staminate members of the plant are more or less short-lived in comparison with the archegonia and pistillate members, the latter requiring more bulk of tissue to serve the purpose of protection and nourisnment to the egg and embryo. It is thus evident that while some progress has been made in the study of this question, we are far from a solution of it. Experiment has proceeded largely from a single standpoint, viz. that of the influence of nutrition. Other factors should be taken into consideration, for there are evidently other external influences and internal forces which play an important *rôle*, as well as certain correlation processes perhaps connected with the osmotic activities of the cell sap.

The relation of the parts of the flower to the foliage leaves is a subject which has from time to time called forth discussion. That they are but modifications of the foliage leaf, or constituents of the leaf concept, is the contention of the metamorphosis theory, and that the so-called sporophylls are modified foliage leaves is accepted with little hesitation by nearly all botanists, though it would be very difficult, it seems to me, for any one to present any very strong argument from a phylogenetic standpoint in favour of the foliage leaf being the primary form in its evolution on the sporophyte, and that the sporophyll is a modern adaptation of the foliage leaf. Numerous cases are known of intermediate forms between sporophylls and foliage leaves both in the Spermatophyta and Pteridophyta. These are sometimes regarded as showing reversion, or indicating atavism, or in the case of some of the ferns as being contracted and partially fertile conditions of the foliage leaf. There has been a great deal of speculation regarding these interesting abnormal forms, but very little experimentation to determine the causes or conditions which govern the processes.

In 1894 I succeeded in producing a large series of these intermediate forms in the sensitive fern (*Onoclea sensibilis*). The experiments were carried on at the time for the especial purpose of determining whether in this species the partially developed sporophyll could be made to change to a foliage leaf, and yet possess characters which would identify it as a transformed sporophyll. The experiments were carried on where there were a large number of the fern plants. When the first foliage leaves were about 25 cm. high, they were cut away (about the middle of May). The second crop of foliage leaves was also cut away when they were about the same height during the month of June. During July, at the time that the uninjured ferns were developing the normal sporophylls, those which were experimented upon presented a large series of gradations between the normal sporophyll and fully expanded foliage leaves. Among these examples there are all intermediate stages from sporophylls which show very slight expansions of the distal portion of the sporophyll, and the distal portions of the pinnæ, until we reach forms which it is very difficult to distinguish from the normal foliage leaf. Accompanying these changes are all stages in the sterilisation of the sporangia (and the formation of prothalloid growths), on the more broadly expanded sporophylls there being only faint evidences of the indusia.

The following year (1895) similar experiments were carried on with the ostrich fern (*Onoclea struthiopteris*), and similar results were obtained. At the time that these experiments were conducted, I was unaware of the experiments performed by Goebel on the ostrich fern. The results he reached were the same; the sporophyll was more or less completely transformed to a foliage leaf. Goebel regards this as the result of the correlation process, and looks upon it as indicating that the sporophyll is a transformed foliage leaf, and that the experiment proves the reality here of the modification which was suggested in the theory of metamorphosis, and thus the foliage leaf is looked upon by him as the primary form. Another interpretation has been given to those results, viz. that they strengthen the view that the sporophyll, from a phylogenetic standpoint, is primary, while the foliage leaf is secondary. What one interprets as a reversion, another regards as indicating a mode of progress in the sterilisation of potentiality, sporogenous tissue, and its conversion into assimilatory tissue. It is perhaps rather to be explained by the adaptive equipoise of the correlative processes existing between the vegetative and fruiting

portions of the plant which is inherited from earlier times. Rather when spore-production appears on the sporophyte could this process be looked upon as a reversion to the primary office of the sporophyte, so that in spore-production of the higher plants we may have a constantly recurring reversion to a process which in the remote past was the sole function of this phase of the plant. In this way might be explained those cases where sporangia occur on the normal foliage leaf of Botrychium, and some peculiar cases which I have observed in *Osmunda cinnamomea*. In some of the examples of this species it would appear that growth of the leaf was marked by three different periods even after the fundament was outlined; the first, a vegetative; second, a spore-producing; and third, a vegetative again; for the basal portions of the leaf are expanded, the middle portions spore-bearing, the passage into the middle portions being gradual, so that many sporangia are on the margins of quite well-developed pinnæ. These gradations of the basal part of the leaf, and their relation to the expanded vegetative basal portion, showing that the transition here has been from partially formed foliage leaf to sporophyll after the fundament was established, and later the increments of the vegetative part from the middle towards the terminal portion, shown by the more and more expanded condition of the lamina and decreasing sporangia, indicate that vegetative forces are again in the ascendency. This suggests how unstable is the poise between the vegetative leaf and sporophyll in structure and function in the case of this species.

For two successive years I have endeavoured by experiment to produce this transformation in *Osmunda cinnamomea*, but thus far without sufficiently marked results. The stem of the plant is stout, and this, together with the bases of the leaves closely overlapping, contain considerable amounts of stored nutriment which make it difficult to produce the results by simply cutting off the foliage leaves. The fact that these transformations are known to occur where fire has overspread the ground, and, as I have observed, where the logging in the woods seriously injured the stools of the plant, it would seem that deeper-seated injuries than the mere removal of foliage leaves would be required to produce the transformation in this species. It may be that such injury as results from fire or the severe crushing of the stools of the plant would be sufficient to disturb the equilibrium which existed at the time, that the action of the correlative forces is changed thereby, and there would be a tendency for the partially developed foliage leaves to form sporangia, then when growth has proceeded for a time this balance is again changed.

The theory that the foliage leaves of the sporophyte have been derived by a process of sterilisation, and that the transformation of sporophylls to foliage leaves, in an individual, indicates the mode of progress in this sterilisation, does not necessarily involve the idea that the sporophyll of any of the ferns, as they now exist, was the primary form of the leaf in that species; and that by sterilisation of some of the sporophylls, the present dimorphic form of the leaves was brought about. The process of the evolution of the leaf has probably been a gradual one, and extends back to some ancestral form now totally unknown. One might differ from Prof. Bower; the examples selected by him to illustrate the course of progress from a simple and slightly differentiated sporophyte to that exhibited in the various groups of the Pteridophyta. But it seems to me that he is right in so far as his contention for the evolution of vegetative and assimilatory members of the sporophyte, can be illustrated by a comparison of the different degrees of complexity represented by it in different groups, and that this illustrates the mode of progress, as he terms it, the sterilisation of potential sporogenous tissue.

On this point it appears that Prof. Bower has been unjustly criticised. The forms selected to illustrate his theory were chosen not to represent ancestral forms, or direct phylogenetic lines, but solely for the purpose of illustrating the gradual transference of spore-bearing tissue from a central to a peripheral position, and the gradual eruption and separation of spore-bearing areas, with the final sterilisation of some of these outgrowths.

To maintain that in phylogeny the sporophyll is a transformed foliage leaf, would necessitate the predication of ancestral plants with only foliage leaves, and that in the case of these plants the vegetative condition of the sporophyte was the primary one, spore production being a later developed function. Of the forms below the Pteridophyta, so far as our present evidence goes, the sporophyte originated through what Bower calls the gradual elaboration of the zygote. All through the Bryophyta wherever a sporophyte is developed, spore production constantly recurs in each cycle of the development, and yet there is no indication of any foliar organs on the sporophyte. The simplest forms of the sporophyte contain no assimilatory tissue, but in the more complex forms assimilatory tissue is developed to some extent, showing that the correlative forces which formerly were so balanced as to confine the vegetative growth to the gametophyte and fruiting to the sporophyte, are later changing so that vegetative growth and assimilation are being transferred to the sporophyte, while the latter still retains the function of spore production, though postponed in the ontogeny of the plant.

If we cannot accept some such theory for the origin of sporophylls and foliage leaves, by gradual changes in potential sporogenous tissue, somewhat on the lines indicated by Bower, it seems to me it would be necessary, as already suggested, to predicate an ancestral form for the Pteridophyta in which spore production was absent. That is, spore production in the sporophyte of ancestral forms of the Pteridophyta may never have existed in the early period of its evolution, and spore production may have been a later development. But this, judging from the evidence which we have, is improbable, since the gametophyte alone would then be concerned in transmitting hereditary characters, unless the sporophyte through a long period developed the gametophyte stage through apospory. Bower says, in taking issue with Goebel's statement that the experiments on *Onoclea* prove the sporophyll to be a transformed foliage leaf: "I assert, on the other hand, that this is not proved, and that a good case could be made out for priority of the sporophyte; in which event the conclusion would need to be inverted, the foliage leaf would be looked upon as a sterilised sporophyll. This would be perfectly consistent with the correlation demonstrated by Prof. Goebel's experiments, as also with the intercalation of a vegetative phase between the zygote and the production of spores." In another place he says:—"To me, whether we take such simple cases as the Lycopods or the more complex case of the Filicineæ, the sporangium is not a gift showered by a bountiful Providence upon pre-existent foliage leaves: the sporangium, like other parts, must be looked upon from the point of view of descent; its production in the individual or in the race may be deferred, owing to the intercalation of a vegetative phase, as above explained; while, in certain cases at least, we probably see in the foliage leaf the result of the sterilisation of sporophylls. If this be so, much may be then said in favour of the view that the appearance of sporangia upon the later formed leaves of the individual is a reversion to a more ancient type rather than a metamorphosis of a progressive order."

As I have endeavoured to point out in another place, if a disturbance of these correlative processes results in the transference of sporophyllary organs to vegetative ones on the sporophyte, "why should there not be a similar influence brought to bear on the sporophyte, when the same function resides solely in the gametophyte, and a disturbing element of this kind is introduced? To me there are convincing grounds for believing that this influence was a very potent—though not the only—one in the early evolution of sporophytic assimilatory organs. By this I do not mean that in the Bryophyta, for example, injury to the gametophyte would now produce distinct vegetative organs on the sporophyte, which would tend to make it independent of the gametophyte. But that in the bryophyte-like ancestors of the pteridophytes an influence of this kind did actually take place, appears to me reasonable.

"In the gradual passage from an aquatic life, for which the gametophyte was better suited, to a terrestrial existence for which it was unadapted, a disturbance of the correlative processes was introduced. This would not only assist in the sterilisation of some of the sporogenous tissue, which was taking place, but there would also be a tendency to force this function on some of the sterilised portions of the sporophyte, and to expand them into organs better adapted to this office. As eruptions in the mass of sporogenous tissue took place, and sporophylls were evolved, this would be accompanied by the transference of the assimilatory function of the gametophyte to some of these sporophylls."

Because sporophytic vegetation is more suited to dry land conditions than the gametophytic vegetation, it has come to be the dominating feature of land areas. Because the sporophyte in the Pteridophyta and Spermatophyta leads an independent

existence from the gametophyte, it must possess assimilatory tissue of its own, and this is necessarily developed first in the ontogeny; but it does not necessarily follow, therefore, that the foliage leaf was the primary organ in the phylogeny of the sporophyte. The provision for the development of a large number of spores in the thallophytes, so that many may perish and still some remain to perpetuate the race, is laid hold on by the bryophytes, where the mass of spore-bearing cells increases and becomes more stable, for purposes of the greatest importance. Instead of perishing, some of the sporogenous tissue forms protecting envelopes, then supporting and conducting tissue, and finally in the pteridophytes and spermatophytes nutritive and assimilatory structures are developed. Nature is prodigal in the production of initial elementary structures and organs. But while making abundant provision for the life of the organism through the favoured few, she has learned to turn an increasing number of the unfavoured ones to good account. Acted upon by external agents and by internal forces, and a changing environment, advance is made, step by step, to higher, more stable, and prolonged periods.

While we have not yet solved any one of these problems, the results of experimental morphology are sufficient to indicate the great importance of the subject and the need of fuller data from a much larger number of plants. If thus far the results of experiments have not been in all cases sufficient to overthrow the previous notions entertained touching the subjects involved, they at least show that there are good grounds for new thoughts and new interpretations, or for the amendment of the existing theories. While there is not time for detailing even briefly another line of experiment, viz. that upon leaf arrangement, I might simply call attention to the importance of the experiments conducted by Schumann and Weisse from the standpoint of Schwendener's mechanical theory of leaf arrangement. Weisse shows that the validity of the so-called theory of the spiral arrangement of the leaves on the axis may be questioned, and that there are good grounds for the opening of the discussion again. It seems to me, therefore, that the final judgment upon either side of all these questions cannot now be given. It is for the purpose of bringing fresh to the minds of the working botanists the importance of the experimental method in dealing with these problems of nature, that this discussion is presented as a short contribution to the subject of experimental morphology of plants.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Sir Archibald Geikie has been appointed the Romanes Lecturer for 1898.

The Delegates of the Common University Fund have appointed Mr. William John Smith Jerome Lecturer in Medical Pharmacology and Materia Medica for the years 1898–99.

CAMBRIDGE.—Mr. J. H. Grace, bracketed second wrangler 1895, has been elected to a fellowship at Peterhouse.

Mr. S. F. Harmer, Superintendent of the Museum of Zoology, has been approved for the degree of Doctor of Science.

Mr. H. K. Anderson, Demonstrator of Physiology, has been elected to a Drosier Fellowship at Gonville and Caius College.

Dr. A. A. Kanthack, of St. John's College, has been elected to the Professorship of Pathology, in the place of the late Prof. C. S. Roy.

The University Lectureship in Midwifery is vacant by the resignation of Mr. E. H. Douty. Applications for appointment are to be sent to the Vice-Chancellor by November 15.

The General Board of Studies have issued a report in which they propose that the time-honoured examination in Paley's "Evidences" shall be discontinued, and that candidates for honours shall in the previous Examination be required to pass in English, French, or German, and also in Mechanics, Physics, or Logic. The report is likely to be keenly discussed.

The State Medicine Syndicate report that in the present year seventy candidates have offered themselves for examination in Sanitary Science, and that thirty-four were approved and received the University diploma in Public Health.

The degree of M.A. *honoris causa* is to be conferred on Mr. C. R. Marshall, Assistant in Pharmacology to the Downing Professor of Medicine.

Among the new Fellows elected at St. John's College on November 9, are Mr. W. McDougall, First Class Natural Sciences Tripos, 1892-94, and Mr. T. J. I'A. Bromwich, Senior Wrangler 1895, First Class Division I. Mathematical Tripos Part II., 1896.

IT is announced that Mr. Jonathan Hutchinson, F.R.S., has signified his desire to found an educational museum at Selby, his native town.

IN connection with North Dakota Agricultural College and Station a new chemical laboratory is in course of construction. Its estimated cost will be about 5000*l*.

DR. MOLLIER, of Göttingen, has been appointed professor of mechanical engineering in the Technological Institute at Dresden.

Science states that the U.S. Geological Survey has practically completed the distribution of the Educational Series of Rocks, 175 sets of 156 specimens each having been sent out during the past summer to universities, colleges and technical institutions in the United States. There remains a small number of incomplete sets, which will be placed in certain smaller colleges. The Educational Series were prepared by the Survey with much care, for the purpose of aiding students in acquiring a general and special knowledge of rocks, and promoting the study of geology.

THE Clerk to the Drapers' Company has informed the Registrar of the University College of North Wales, Bangor, that the Company will modify, in the sense suggested by the College, the conditions attached to their grant of 1000*l*. towards stocking and equipping the College farm. The grant is therefore now made conditionally upon a further sum of 3000*l*. being raised towards the same purpose before the end of the present session. It has been arranged that students pursuing the ordinary agricultural course at the College shall in future reside for a part of that course in the immediate neighbourhood of the farm, and thus get the benefit of practical training, side by side with the theoretical instruction. The College enters upon its tenancy of Lledwigan this week.

SCIENTIFIC SERIALS.

THE current number (July) of the *Monthly Weather Review* (Washington) contains a paper on the observation of halo phenomena. This is a translation of a reprint of an article by the Rev. K. Schips in the Year-book of the Natural History Association, a copy of which we have received. A committee has been formed in Germany for the study of halos, and a request is made for the regular observation of these phenomena, as it appears that the subject of meteorological optics receives no great attention, except in Japan. The paper will be found instructive to both observers and students.—The equations of hydrodynamics in a form suitable for application to problems connected with the movements of the earth's atmosphere, by J. Cottier. This contribution is of much importance to those who are studying the fundamental problem of meteorology. Mr. Cottier, who was a student of brilliant promise, unfortunately died on August 17.—Rain gushes in thunderstorms, by the editor (Prof. Cleveland Abbe). Several plausible explanations of this phenomenon have been put forward from time to time, but have been rejected as erroneous. It is at present an open question whether the gushes of rain bring about the formation of lightning, or *vice versâ*. Several suggestions are made by the editor, which require to be tested by further experiment.—Among various other notes there is an interesting one, entitled "Kites at the Chicago Conference, August 1893." This method of obtaining information relating to the upper air is daily becoming more popular, and seems likely to lead to useful results.

Bollettino della Società Sismologica Italiana, vol. iii. N. 2, 1897.—On an old mercurial seismometer designed by A. Cavalli, by G. Agamennone.—Geological observations on the Florentine earthquake of May 18, 1895, by C. De Stefani. An abstract of a memoir published in the *Annali* of the Central Meteorological Office.—Notes of earthquakes recorded in Italy (February 4–18, 1897), by G. Agamennone, the most important being the earthquake of Sicily and Calabria of February 11–12, and five earthquakes of unknown but distant origin, one on February 7, two on February 13, and two on February 15.

SOCIETIES AND ACADEMIES.

CAMBRIDGE.

Philosophical Society, October 25.—Mr. F. Darwin, President, in the chair.—The following elections were made: President—Mr. F. Darwin. Vice-Presidents—Prof. Newton, Prof. J. J. Thomson, Mr. Larmor. Treasurer—Mr. Glazebrook. Secretaries—Mr. Newall, Mr. Bateson, Mr. Baker. New Members of Council—Mr. Harker, Mr. Hutchinson, Prof. Liveing, Mr. Skinner.—The following communications were made: Electrical oscillations in wires, by Mr. H. C. Pocklington. In this paper are discussed some problems relating to electrical oscillations about wires made of perfectly conducting material and of circular cross-section. The first step is to find an expression for the electrical forces which satisfies the space differential equations, and gives infinite values for the forces near the wires. It is then shown that the arbitrary function contained in that expression can be so chosen as to make the value of the component of the electric force tangetial to the surface of the wire vanish if small quantities of the first order be neglected. The value of this arbitrary function is found in the case of a circular wire, and equations are found for the period of oscillation and the decrement of the oscillation. These equations are solved in the case when the wire is so thin that it is permissible to neglect not only its radius in comparison with the circle, but even the square of the reciprocal of the logarithm of its radius in comparison with unity. In this case the alteration in period and the damping depend on the logarithm of the ratio of the radii of the wire and the circle. As a corollary, the problem of the resonance of a complete circular resonator is discussed. It is found that when accurately tuned, the magnitude of the current induced is independent of the thickness of the wire, and that the thinner the wire the more sensitive it is to accuracy of tuning. The case of waves propagated along a helical wire is next considered, a general equation being found in which small quantities are neglected. The case when the reciprocal of the radius of the wire can be neglected is discussed in detail. For this case it is found that when the period is not great, there are two velocities of propagation possible, one with a velocity (v) measured along the wire, equal to that of light, the other with a greater velocity. If, however, the period is greater than a certain finite value, the former mode of propagation only is possible. If, however, the period is very great, the velocity of propagation may be greater than v, and if the period is so great that the product of the wave-length in free space into the diameter of the wire is very great compared with the square of the diameter of the helix, the velocity attains a limiting value equal to v when measured along the axis of the helix.—On circles, spheres, and linear complexes, by Mr. J. H. Grace. Clifford in his paper on Miquel's theorem gave an infinite series of theorems commencing with the fact that, given four lines, the circumcircles of the triangles formed by them meet in a point. The present paper contains a more general series of theorems in two dimensions, and a somewhat analogous series in three dimensions. Also the first theorem of the set for four dimensions is proved. Then the method of Klein ("Linien-Geometrie und metrische Geometrie," *Math. Ann*, v.) is used to transform these results into theorems regarding linear complexes and straight lines; and the transformation of Lie (*Math. Ann.*, v.) is used to obtain, from properties of straight lines and linear complexes, results concerning spheres and their angles of intersection.—Theorems relating to the product of two hypergeometric series, by Mr. W. McF. Orr. This paper deals with such theorems as that stated by Cayley, *Phil. Mag.*, November 1858 (Collected Papers, vol. iii. p. 268).—Reduction of a certain multiple integral, by Mr. Arthur Black. The integral dealt with is one in n variables; the subject of integration is one involving an exponential of which the index is a general quadratic function of $n + 1$ variables.—On the gamma function, by Mr. H. F. Baker. This note deals with the uniform convergence of a certain limiting process.—On the lines of striction of a hyperboloid, by Mr. H. F. Baker. This note remarks on the known fact that the line of striction belonging to either system of generators is a unicursal quartic curve, and considers the parametric expression of more general forms of octavic curves with six double points.—On the action of the radiation from uranium salts on the formation of clouds, by Mr. C. T. R. Wilson. It has been shown in previous papers (*Proc. Roy. Soc.*, vol. lix. p. 338, 1896; *Phil. Trans.*, vol. clxxxix. A, p. 265, 1897) that under the action of Röntgen rays, nuclei are produced in moist dust-free air, capable of acting as centres of condensation, when the air, initially saturated, suffers a sudden expansion such that v_2/v_1, the ratio of the final to the initial volume, exceeds 1·25. Nuclei requiring exactly the same degree of supersaturation are present in very small numbers in moist dust-free air under ordinary conditions. Recent experiments show that the radiation from uranium salts introduces nuclei, again requiring exactly the same degree of supersaturation, in order that condensation may take place upon them. The nuclei are many times more numerous than in the absence of the rays.

PARIS.

Academy of Sciences, November 2.—M. A. Chatin in the chair.—Actinometry in balloons, by M. J. Violle. Actinometric observations from balloons should possess many advantages over those taken on the earth, as the complete absence of dust is assured, and the air layer is also reduced. A trial ascent in the *Balaschoff*, by MM. Hermite and Besançon, showed that the radiation from the balloon itself was a negligable quantity; but from the results obtained, it would appear that there was still above the balloon such a quantity of water as in the liquid state would form a column of several centimetres in thickness.—On the preparation and properties of the borides of calcium, strontium, and barium, by MM. H. Moissan and P. Williams. The boride of calcium is formed by heating a mixture of dry calcium borate, aluminium, and sugar charcoal in a carbon crucible in the electric furnace for seven minutes (900 ampères and 45 volts). The duration and regularity of heating has a great influence upon the yield. The boride is obtained as a black crystalline powder, so hard that it readily scratches rock crystal. Chemically it is not easily decomposed, dry hydrogen at a red heat, nitrogen at 1000°, and water at ordinary temperatures being without action upon it. Fluorine attacks it in the cold with incandescence, but the other halogens only destroy the boride at a red heat. The borides of strontium and barium are prepared in the same way, and possess analogous properties. The formula of these compounds, RB_6, is identical with that of the hydrozoates of Curtius, RN_6.—Occultation of the group of the Pleiades by the moon on October 13, 1897, at Lyons, by M. Ch. André.—Observations on the Perrine comet (November 2, 1896) made at the observatory of Rio de Janeiro, by M. Cruls.—New demonstration of the fundamental theorem of projective geometry, by M. H. G. Zeuthen.—On the determination of the integrals of a partial differential equation by certain initial conditions, by M. E. Goursat.—On the problem of M. Bonnet, by M. C. Guichard.—Compressibility of gases at different temperatures at pressures near that of the atmosphere, by M. A. Leduc.—On the atomic weights of argon and helium, by M. H. Wilde.—On the stannic acids, by M. R. Engel. A *résumé* of the work on the stannic acids, with an explanation of some of the apparent contradictions.—Use of fluorescine for the detection of traces of bromine in a saline mixture, by M. H. Baubigny. The bromine is set free by a mixture of potassium permanganate and copper sulphate, and the vapours evolved allowed to impinge upon fluorescine paper. The presence of as little as ·001 gr. of bromine in 10 gr. of common salt is shown by a reddish coloration of the paper due to the formation of eosin.—On the crystallographic identity of the dextrorotatory and lævorotatory asparagines, by M. P. Freundler. The accuracy of Pasteur's law having been called in question by M. Walden from certain experimental determinations of M. Grattarola on the two asparagines, these angular measurements have been redetermined, with the result that the deviations found are well within the limits of experimental error.—Study of the transformation of sugars occurring in olive oil, by M. C. Gerber.—Mixed grafting, by M. L. Daniel. A description of a new mode of grafting which gives better results when the two plants present marked physiological differences.—On the evolution of the black rot, by M. A. Prunet. Injection may take place through the leaves of the vine at a certain stage of development, after which the leaves lose their susceptibility to black rot. It is just before this critical period that remedial measures should be applied to the leaves.—On the age of the grits containing *Sabalites andegavensis* in the west of France, by M. Jules Welsch.—New researches on the Ostioles, by M. J. J. Andeer.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 11.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Accumulator Traction on Rails and Ordinary Roads: L. Epstein.

MATHEMATICAL SOCIETY, at 8.—On the Poncelet Polygons of a Limaçon: Prof. F. Morley.—On an Extension of the Exponential Theorem: J. E. Campbell.—The Integral $\int P_n^2 dx$ and Allied Forms in Legendre's Functions, between Arbitrary Limits: R. Hargreaves.—The Character of the General Integral of Partial Differential Equations: Prof. Forsyth, F.R.S.—The Calculus of Equivalent Statements (No. 7): H. MacColl.

FRIDAY, NOVEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 8.—On the Nature of the Orbit of γ Lupi: T. J. J. See.—List No. 4 of Nebulæ discovered at the Lowe Observatory: Lewis Swift.—Equatorial comparisons of Uranus with 41 Libræ, and a probable Occultation of the Star by the Planet: John Tebbutt.—On the Effect of Chromatic Dispersion of the Atmosphere on the Parallaxes of α Centauri and β Orionis; and on a Method of Determining its Effect on the Value of the Solar Parallax derived from Heliometer Observations of the Minor Planets: David Gill.—The Great Equatorial Current of Jupiter: A. Stanley Williams.—Approximate Ephemeris of the Leonids from 1897 December 24 to 1898 April 8: G. Johnstone Stoney.—On the Effect upon the Moon's Motion of a Hypothetical Change in the Law of Gravitation: Robert Bryant.—A Spectroscopic Method for Determining the Second and Third Contacts during a Total Eclipse of the Sun: Wm. Shackleton.—Note on a Result used by Prof. Wadsworth in several recently published Papers: H. F. Newall.

MALACOLOGICAL SOCIETY (in the apartments of the Linnean Society), at 8.—Malacological Notes made during a Journey through Russia; with some Account of Dredgings in the Black Sea: G. F. Harris.—Description of a New Species of *Mülleria* from India: Edgar A. Smith.—Note on a Variety of *Rhaphaulus Lorraini*, with a List of the known Species: Edgar A. Smith.—On *Streptaxis gracilis*, a New Species from Ceylon: Oliver Collett.—Revision of the New Zealand Rissoiidæ: H. Suter.

PHYSICAL SOCIETY (in the rooms of the Chemical Society), at 4.—Council Meeting.—At 5.—On the Isothermals of Ether: J. Rose-Innes.—On the Variation with Temperature of the Electromotive Force of the H-Form of Clark Cells: F. S. Spiers and F. Twyman.

TUESDAY, NOVEMBER 16.

ZOOLOGICAL SOCIETY, at 8.30.—On British Medusæ: E. T. Browne.—On Three Consignments of Butterflies collected in Natal in 1896 and 1897 by Guy A. K. Marshall: Dr. A. G. Butler.—On the Sydney Bush-Rat (*Mus arboricola*): Edgar B. Waite.

MINERALOGICAL SOCIETY, at 8.—Anniversary Meeting.—Election of Officers and Council.—On Augelite from Bolivia: L. J. Spencer.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Manchester Ship Canal; Sir E. Leader Williams.—The Eastham Division: Whately Eliot. The Runcorn Division: Sir E. Leader Williams. The Irlam Division: W. O. E. Meade-King.

ROYAL STATISTICAL SOCIETY, at 5.30—Notes on the Subjects discussed at the Meeting of the International Statistical Institute at St. Petersburg, 1897: Major P. G. Craigie.

ROYAL PHOTOGRAPHIC SOCIETY, 12 Hanover Square, W., at 8.—A Review of Triple Printing Methods: E. Sanger Shepherd.

WEDNESDAY, NOVEMBER 17.

SOCIETY OF ARTS, at 8.—The Colonies: their Arts, Manufactures, and Commerce: Sir Owen Tudor Burne.

GEOLOGICAL SOCIETY, at 8.—The Geology of Rotuma: J. S. Gardiner.—A Geological Survey of the Witwatersrand and other Districts in the Southern Transvaal: Dr. F. H. Hatch.—Observations on the Genus *Aclisina* de Koninck, with Descriptions of British Species and some other Carboniferous Gasteropoda: Jane Donald.

ENTOMOLOGICAL SOCIETY, at 8.—Some Results obtained from the Hybridisation of Allied Species: J. W. Tutt.

ROYAL METEOROLOGICAL SOCIETY (at the Institution of Civil Engineers), at 7.30.—Results of a Comparison between the Sunshine Records obtained simultaneously from a Campbell Stokes Burning Recorder and from a Jordan Photographic Recorder: Richard H. Curtis.

ROYAL MICROSCOPICAL SOCIETY, at 8.

SANITARY INSTITUTE, at 8.—A Discussion on the Pollution of Water Supplies by Encampments of Hop-Pickers, Casual Workers, Tramps, &c.: to be opened by Prof. W. H. Corfield, in reference to the Dangers of Pollution of Municipal Water Supplies; and by Miss M. A. Chreiman, in reference to the Sanitary Control of Hop-Pickers, &c.

THURSDAY, NOVEMBER 18.

ROYAL SOCIETY, at 4.30.—Account of a Comparison of Magnetic Instruments at Kew Observatory: C. Chree, F.R.S.—Note on the Influence of very Low Temperatures on the Germinative Power of Seeds: H. T. Brown, F.R.S., and F. Escombe.—On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. II. On *Spencerites*, a New Genus of Lycopodiaceous Cones from the Coal Measures, founded on the *Lepidodendron Spenceri* of Williamson: D. H. Scott, F.R.S.—The Histology of the Cell-wall, with special reference to the Mode of Connection of Cells: W. Gardiner, F.R.S.—Mathematical Contributions to the Theory of Evolution. IV. On the Probable Errors of Frequency Constants, and on the Influence of Random Selection on Variation and Correlation: Prof. K. Pearson, F.R.S., and L. N. G. Filon.—On the Geometrical Treatment of the "Normal Curve" of Statistics, with especial reference to Correlation, and to the Theory of Error: W. F. Sheppard.

LINNEAN SOCIETY, at 8.—On *Pontobolbos manaarensis*: Prof. A. Dendy.—On Haddonia, a New Genus of Foraminifera: F. Chapman.

CHEMICAL SOCIETY, at 8.—On the Decomposition of Camphoric Acid by Fusion with Potash or Soda: Dr. A. W. Crossley and W. H. Perkin, jun., F.R.S.—Experiments on the Synthesis of Camphoric Acid: W. H. Bentley and W. H. Perkin, jun., F.R.S.—The Action of Magnesium on Cupric Sulphate Solution: Dr. Frank Clowes and R. M. Caven.—Properties and Relationships of Di-hydroxytartaric Acid: H. J. Horstman Fenton.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—Memorials Journal and Botanical Correspondence of C. C. Babington, F.R.S. (Cambridge, Macmillan and Bowes).—North America. Vol. 1. Canada and Newfoundland: S. E. Dawson (Stanford).—Resultate der Wissenschaftlichen Reforschung des Balatonsees, Zweiter Band, Erster Theil (Wien. Hölzel).—Bau und Leben unserer Waldbäume: Dr. M. Büsgen (Jena, Fischer).—The Practice of Massage: A. S. Eccles, 2nd edition (Baillière).—Air, Food, and Exercises: Dr. A. Rabagliati (Baillière).—Gases: their Constitution and Functions: S. J. Corrigan, Part 3 (St. Paul, Minn.).—Die Zigeuner: Prof. G. Cora (Turin).—The Meteorology of Edinburgh: R. C. Mossman, 2 parts (Edinburgh, Grant).—A System of Medicine: edited by Dr. Clifford Allbutt, Vol. iv. (Macmillan).—Les Constantes Physico-Chimiques: D. Sidersky (Paris, Gauthier-Villars).—Bibliography of X-Ray Literature and Research (1896–97): edited by C. E. S. Phillips (*Electrician* Company).—William Harvey: D'Arcy Power (Unwin).—A History of Fowling: Rev. H. A. Macpherson (Edinburgh, Douglas).—Botanisches Bilderbuch für Jung und Ult: F. Bley (Berlin, Schmidt).—University College, Nottingham, Calendar, 1897–98 (Nottingham, Sands).

PAMPHLETS.—Random Shots at Birds and Men: "Jim Crow" (Roxburghe Press).—Notions Générales sur L'Ecorce Terrestre: Prof. A. de Lapparent (Paris, Masson).

SERIALS.—Century Magazine, November (Macmillan).—Journal of the Sanitary Institute, October (Stanford).—Reale Istituto Lombardo di Scienze e Letture, Rendiconti, serie ii. Vol. xxx. Fasc. xvi. (Milano).—American Naturalist, October (Philadelphia).—Astrophysical Journal, October (Chicago).—The Atoll of Funafuti, Part 4 (Sydney).—Zeitschrift für Physikalische Chemie, xxiv. Band, 2 Heft (Leipzig).—Anales del Museo Nacional de Buenos Aires, Tome v. (Buenos Aires).—Geological Magazine, November (Dulau).—Scribner's Magazine, November (Low).—Journal of Botany, November (West).—History of Mankind: F. Ratzel, translated, Part 21 (Macmillan).—Fortnightly Review, November (Chapman).—Knowledge, November (Holborn).—Gazzetta Chimica Italiana, 1897, Parte ii. Fasc. iv. (Roma).—Geographical Journal, November (Stanford).—Transactions of the Rochdale Literary and Scientific Society, 1896–97 (Rochdale).—North American Fauna, No. 13 (Washington).—Strand Magazine, November (Newnes).—Nansen's Farthest North, Part 1 (Newnes).—Mémoires de la Société de Physique et d'Histoire Naturelle de Genève, Tome xxxii. seconde Partie (Genève).—American Journal of Science, November (New Haven).

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THURSDAY, NOVEMBER 18, 1897.

THE MATHEMATICS USED IN CONNECTION WITH PHYSICS.

The Theory of Electricity and Magnetism; being Lectures on Mathematical Physics. By A. G. Webster, Assistant Professor of Physics, Clark University, Webster, Massachusetts. Pp. xii + 571. (London: Macmillan and Co., Ltd., 1897.)

THE aim of the writer, according to the preface, in the preparation of this volume has been to present to the students the results of the Maxwellian theory as it stands at present, after the labours of Faraday, Maxwell, Helmholtz, Hertz, and Heaviside.

Prof. Webster is a somewhat young man of marked promise, whose contributions to the discussions in Section A of the British Association formed one of the features of the meeting of that section at Toronto this year, and the book shows that he is fully capable of appreciating the mathematical significance of physical facts. It is doubtful, however, whether a student would be able to appreciate the physical significance of the mathematical theory from reading it. Possibly the students of the Clark University, when listening to such lectures as are given in this treatise, have the physical meanings of the various mathematical processes explained to them. If not, they must possess an exceptional amount of ability to enable them to arrive at correct physical interpretations of the mathematical equations.

The first fifty-two pages of the book are occupied with a short summary of the principles of the vector calculus, the definitions of variables, functions, differential coefficients, definite integrals, line and surface integrals, something about the calculus of variations, &c. It is not quite obvious what is the object of giving this, since a student who was capable of following the book would understand the meaning of a differential coefficient before opening it; or if, on the other hand, he was ignorant of the differential and integral calculus, he would require far more detailed information than is given in these fifty-two pages before he could tackle triple integrals, vector differential operators, &c., which are used quite early in the book.

Is it correct to say that, "following the usage of the majority of writers, we shall denote

$$\frac{\delta^2}{\delta x^2} + \frac{\delta^2}{\delta y^2} + \frac{\delta^2}{\delta z^2}$$

by Δ," seeing that many writers, including Thomson and Tait, use ∇^2, and Maxwell $-\nabla^2$?

Gauss' theorem may undoubtedly be stated as a piece of mathematical analysis, as it is done on pp. 75–78; but the theorem would be perfectly useless if gravitational, electric, and magnetic forces did not vary as the inverse square of the distance. When, therefore, the theorem is divorced from all physical application or interpretation, is not the student less likely to grasp it and to remember it?

The last section of the introductory chapter, which brings us to p. 91, discusses the theory of functions of a complex variable with clearness and conciseness; and this section might with advantage have been extended, and some of the earlier portion of the book omitted.

Part i., which commences on p. 91, is on the "Theory of Newtonian Forces"; but forces as realities, and not merely letters which satisfy a number of equations, have not much existence in the chapter. Take, for example, d'Alembert's principle described on p. 107 This principle is in reality the result of an argument based on Newton's laws, and leads to a valuable set of equations in dynamics. The reader, however, is not told this, but only that the analytical statement of d'Alembert's principle is given in Lagrange's equation of virtual velocities. This equation, Mr. Webster rightly states, involves all the internal forces, and so the student might not suspect that the essence of d'Alembert's principle was the elimination of these internal forces.

The rest of the Part i. is good, the subject of attractions being well and lucidly treated. Does not, however, the introduction of the n axes of the harmonic of the nth degree add unnecessary difficulty, and somewhat hide the beauty of harmonic analyses? For students who already possess a good knowledge of magnetism, the treatment of polarised distributions will be useful.

Although the title of this book, as given on the cover, is "Electricity and Magnetism," it is not until p. 243, or nearly the middle of the book, that we come to the portion that deals specially with electricity. The statement of the general problem of electrostatics, as given at the beginning of § 135, is insufficient since, as pointed out, any number of solutions could be given to it. The method, however, which is indicated for the solution of the problem is correct, and leads in a neat way to the conception of coefficients of induction from which the coefficients of potential are deduced.

§ 151, on Green's function, like much of the matter in the book, is divorced from its physical application, so that a student will hardly see the physical nature of the problem that Green set himself to solve, or the method by which he solved it. In fact, the author criticises Green's work as follows:—

"Reasoning depending on such physical facts was frequently made use of by Green, and while not legitimate for purposes of mathematical demonstration, is frequently of service to the physicist."

The discussion, however, of the application of conjugate functions is good.

It is not the custom in this country to call the conductor of a Wheatstone's bridge, in which the galvanometer is inserted, "the bridge wire," and we are not aware that this practice is followed in America either.

On page 357 the author defines μ as the *inductivity* of the medium, and explains that this becomes specific inductive capacity in the electric case, and permeability in the magnetic. This analogy is, of course, quite correct, but it is carried too far when the same letter μ is used for specific inductive capacity on some pages and for magnetic permeability on others. In considering the dimensions of the electrostatic and electromagnetic systems of units, the propagation of waves, &c., the beginner

might expect to find μ' instead of which he finds $\epsilon\mu$; the meaning, however, of this ϵ does not seem to be given, and he is left to discover for himself that this ϵ stands for the specific inductive capacity for which μ has been previously employed.

We should prefer to say that the *absolute* dimensions of specific inductive capacity and of permeability were yet unknown rather than they were "arbitrary," and we do not agree with the statement that attempts to settle their absolute dimensions are evidently based upon misconceptions of the theory of dimensions.

The statement that "for magnetic bodies as the force increases μ diminishes" is generally correct, but not sufficiently guarded, seeing that the very opposite is the case for small forces; and more explanation is required as to the meaning, or the necessity, of the statement:—"The variability of μ does not affect the validity of Ohm's Law, which determines the distribution of the laws of induction."

The last chapter in Part ii., on the conduction in dielectrics, contains some interesting work, such as that on the effect of heterogeneity.

Part iii. deals with the electromagnetic field in a lucid and satisfactory manner. We feel somewhat divided in our judgment regarding Mr. Webster's inability to respond to Boltzmann's appeal that Maxwell's notation should be followed. It will undoubtedly be somewhat perplexing for the student to have to employ X, Y, Z for the components of electric field intensity when he reads this book, and for the components of a mechanical force when he is studying Maxwell's classical treatise. But Mr. Webster is an American, and the secret of the success of his countrymen lies in their having gone ahead instead of merely following precedent. Hence, whatever may be the wrench we feel at being torn away from our time-honoured notation, we must respect Mr. Webster's independence in employing what he considers a better one.

The book finishes with an excellent introduction to the theory of electromagnetic waves, which deals with the more important points of this subject in a clear and concise manner. The statement made on page 550, that the matter on the preceding seventeen pages applies only to a submarine cable of infinite length, should have come much earlier; for, on reading these pages, we certainly thought that the author was under the mistake of imagining that the treatment applied equally well to a finite cable.

On page 536 the author pokes fun at established authority by giving more than one reason why long-distance telephony has not existed in England, and on page 547 he sits in judgment on Mr. Heaviside in an equally humorous way, although in this case the fun is not intentional on the part of the author.

The book is on the whole distinctly good, and any one who has mastered it will possess a sound acquaintance with the most important parts of mathematical electricity. The absence of reference to experimental methods is, as stated in the preface, intentional, and, of course, no practical applications of electricity are referred to. But, even if this system has been followed as a protest against those who forget that the practice of to-day was the theory of yesterday, we would suggest that a course of "Lectures on Mathematical Physics" may fitly contain explanations of the physical interpretations of the equations developed without running the risk of appearing to pander to the needs of the electrical contractor.

W. E. A.

THE ELECTRICAL PHENOMENA OF NERVE.

Lectures on Physiology. (First Series.) *On Animal Electricity.* By A. D. Waller, F.R.S., &c. Pp. viii + 144. (London: Longmans, 1897.)

AS Fullerian Professor of Physiology, Dr. Waller has published a series of lectures on the electrical properties of nerve, in which he tells us that his aim has been to give "an exposition of the principal data" relating to the subject. Such of these data as have been derived from his own experiments have been already made known by him in his published papers; but the physiological reader will find it much easier to appreciate their value, now that they are placed before him in connection with facts already known to him. A point of great scientific interest in Dr. Waller's work consists in the circumstance that he has adopted and strictly adhered to a uniform method of "testing" the physiological conditions of a nerve. The gratitude of the reader is further excited by the perspicuity with which the method itself and the first fruits of its application are described, as well as by a vividness of style which makes him feel as if he had been present at the demonstrations.

Dr. Waller's object is to prove that the phenomenon by which a separated nerve most strikingly shows its vitality—the negative variation of du Bois-Reymond—is also a measure and criterion of the physiological condition of the nerve. For this purpose he employs an automatic arrangement by which at regular intervals of a minute, the appropriate "stimulus" for producing this effect is applied to the nerve, at the same time that the electrical "response" made by the nerve is recorded photographically. The effect thus recorded—the negative variation just mentioned—is the *diminution* of the so-called nerve current, the amount of which diminution is indicated by the deflections of a galvanometer connected with the nerve in the usual way. Consequently, so long as the strength and duration of the stimulus (a succession of induction currents led through the nerve at a distance from the part under observation) remains constant, the perfect uniformity of the periodical deflection indicates that the state of the nerve is unaltered; and the effect of any other condition, as, *e.g.* acid or alkaline reaction, change of temperature, &c., manifests itself by augmenting or reducing the deflection. As evidence that the deflection itself is a "vital" one, that is, one belonging to the living nerve as such, it is shown that the transient loss of function which follows the action of the vapour of ether is accompanied by an equally transient disappearance of the normal electrical reaction of the nerve, and again, that the presence of carbon dioxide in the saturated atmosphere in which the nerve is placed for observation, even in the smallest quantity, augments in an equally remarkable way the power of the nerve to respond to stimulation.

In the third lecture Dr. Waller sets forth further interesting facts relating to the mode of action of carbonic acid gas, and compares it with the effects of repeated stimulation, drawing certain inferences as to the agency of this body in producing fatigue, which it would be out of place to criticise here.

The fifth and sixth lectures are devoted to the elucidation of certain changes in the electromotive properties of living nerve, to which half a century ago du Bois-Reymond applied the term electrotonus. Using the method of observing and recording the responses to periodical automatic stimulations already referred to, Dr. Waller demonstrates du Bois' extrapolar electrotonic currents in such a way as to enable the audience to judge of their correspondence with phenomena of the same kind observed in "core models" (*i.e.* cylindrical conductors of which the cores are metallic, the sheaths soaked with solutions of electrolytes), and finally proves, as before, with the aid of ether vapour, that although these phenomena resemble those of physical polarisation so closely, they are, notwithstanding, dependent on a vital activity which the nerve loses and recovers again when for a few minutes put to sleep by the anæsthetic. In the last lecture Dr. Waller goes into the rather more recondite phenomena of "polarisation increment and decrement." His mode of exposition of this subject is so original that one begins to fear that he is about to demolish the interpretation of these phenomena which has been given by his distinguished predecessors in this field of investigation. Happily it is not so. When the time comes for explaining, the instructed reader is gratified to find that although the terms employed are peculiar and unusual, there is nothing abnormal about the doctrine. "Active tissue is zincative, resting tissue is zincable." Consequently in a living nerve through a certain bit of which a battery current is flowing, the anode is more zincable than the kathode; for the living substance of the nerve is at rest at the anode, awake at the kathode. But what does zincable mean? It is a word which Dr. Waller proposes to introduce into scientific terminology because he cannot find an English equivalent for the German "leistungsfähig." Regarding the "Leistung" of a nerve to be chiefly electrical, its "Leistungsfähigkeit" is its "capability of being aroused to electromotive action" (p. 83)—a property which he emphatically distinguishes from "excitability," rightly holding that this word ought only to be used to denote the facility with which a response is evoked.

Dr. Waller's explanation of the increment and decrement is that the diminished excitability which is the well-known effect of the anode during the flow of a voltaic current along a nerve, is necessarily associated with what he calls increased zincability. Hence if the nerve passes from the electrotonic into the excited state, those parts which are most zincable are most susceptible of excitatory change. The point which is thus enforced—that is, the association of increased capability with diminished promptitude to reaction—is a fundamental one in the physiology of all excitable tissues. There can be no doubt that in relation to the phenomena now in question, it has been brought out in a more striking way than before by Dr. Waller's excellent forms of experiment, his lucid description, and the admirable diagrams which make those descriptions easy to follow.

J. B. S.

NOTES OF A NATURALIST AND ANTIQUARY.

Memories of the Months; being pages from the Note-book of a Field Naturalist and Antiquary, to wit, Sir Herbert Maxwell, Bart., M.P. Crown 8vo. Pp. xii + 300. (London: Edward Arnold, 1897.)

THE competitive exactions of business and social pleasure have their reaction. An increasing number of people are turning with interest to the study of natural history, and are willing to learn from those who can write about it. This is a hopeful sign to those who believe that the social health and physical standard of the nation depend in large measure on affection for country life, and that it would be an evil thing should field and flood cease to afford attractions for active minds. As Sir Herbert Maxwell truly remarks, no head is constructed to carry about an explanation of half the things noticed in the course of a single morning's walk; but if notes are made at the moment of what attracts the eye, be it a landscape, a ruin, a battle-field, a flower, bird, or insect, recourse may be had at home to the information abundantly stored in books, and the significance of what seemed commonplace or trivial becomes evident at once. Without attempting to become a specialist himself, every one has at command the accumulated fruits of the labours of specialists.

Acting upon this conviction, it would appear that Sir Herbert Maxwell has long been in the habit of making wayside notes on a variety of subjects, and from time to time has amplified and published them for the benefit of others.

His method of presenting them to the reader is not very new, as will be perceived by those who are acquainted with the Rev. Robert Willmott's "Summer Time in the Country," Mr. Oswald Crawfurd's "Round the Calendar in Portugal," Prof. Miall's "Round the Year," and other books of a similar nature; and it might, perhaps, have been better to have arranged his miscellaneous and fragmentary notes under zoological, botanical, and antiquarian headings, instead of grouping them, as he has done, under the headings of the months to which more often than not they have no particular relation. This plan would have been more convenient to specialists as affording them the opportunity of at once finding all that relates to their own subject, instead of having to search for scattered notes through three hundred pages.

No one, however, who dips into this little volume will begrudge the time bestowed upon it, for whether he be in search of particular information on a given subject or not, he will perforce linger upon many a page wherein he will find both amusement and instruction.

What more amusing, for example, than the author's account (pp. 259–266), of the attempts made to decipher the inscription on the celebrated Ruthwell Cross, variously interpreted—and by experts too—as Runic

Old Norse, and Anglo-Saxon; or his explanation (p. 184) of the reason for keeping cattle in herds.

For instruction we may turn to such chapters as those on the "Revival of a primitive fauna," on "West coast meteorology," or on "Assisted vision." Some of the pleasantest reading is to be found in the pages which give the results of the author's out-of-door observation. Here, for example, is a note on the enmity between bees and butterflies:—

"All kinds of stonecrop possess peculiar attractions for bees and butterflies owing to their abundant secretion of honey. One of the tall growing kinds, *Sedum spectabile*, is by far the handsomest. It is the latest to flower, and its great, flat, rosy corymbs are irresistible to that splendid autumn butterfly, the Red Admiral. . . . I have been watching a number of these robust insects busy on the large stonecrop—so busy as to allow me to use a lens on them. There were no less than sixteen Admirals at work on one group of *Spectabile* stonecrop. The honey bees, however, interfered with them, and it was curious to see how shrewdly a Red Admiral would sheer off at the approach of a bee of less than one-tenth of his own bulk. . . . Now, how do butterflies learn to dread a bee? How do they know that bees are armed? It can hardly be by experience, for no butterfly could survive the stab of a bee's sting. It is part of the mystery enveloping the intelligence of animals not personally educated by their parents. . . . The phases of insect life—the egg abandoned by the parent, the stages of larva, pupa, and imago—seem specially calculated to interfere with hereditary knowledge, and to prohibit the communication of instruction. . . . This avoidance of bees by butterflies seems to be an instance of pure instinct."

On another page, in the course of some remarks on the choice of food by animals, the author alludes to the fact that some creatures will thrive upon plants which to others are poisonous, and instances the case of the Spurge Hawk Moth (*Deiliphila euphorbiæ*), of which the caterpillar feeds exclusively on the Sea Spurge, although this plant secretes an acrid juice "so painfully poisonous that it is difficult to imagine a digestive apparatus competent to deal with it." He might have mentioned the still more curious case of the caterpillar of another moth, *Deiopeia pulchella*, which feeds on the virulent poison contained in the seed of the Esere or "Ordeal Bean" of Old Calabar (*Physostigma venenosum*), and is unaffected by it (*cf.* Dr. T. R. Fraser, *Ann. Mag. Nat. Hist.*, May 1864).

We should like to know the authority for the statement (p. 141) that in the lines from the "Midsummer Night's Dream" (So doth the woodbine the sweet honeysuckle gently entwist), Woodbine means the Bittersweet or Deadly Nightshade. This interpretation appears to have the sanction of Dr. Prior in his "Popular Names of British Plants," but is opposed to the view of Canon Ellacombe, who has made a special study of the "Plant-lore of Shakespeare."

We have noted other passages on which criticism might be offered did space permit; but enough has perhaps been said to indicate the scope of the volume. While too much in the nature of a scrap-book to entitle it to praise as a literary effort, it has the merit of being distinctly entertaining, and of conveying in a light, pleasant style a variety of information on subjects of more or less interest.

OUR BOOK SHELF.

Notes on Micro-organisms Pathogenic to Man. By Surgeon-Captain B. H. S. Leumann, Indian Medical Service. Pp. 96. (London: Longmans, Green, and Co., 1897.)

THIS compact and well-written little volume does not make any pretensions to be a text-book in the ordinary sense of the word, and we should be sorry if the "students and practitioners" for whom it is intended should in their turn make any pretensions to a knowledge of the subject after its perusal. Indeed, students and practitioners "who have no opportunity of working at the subject themselves, or time to read a larger book," had better remember the old adage, a little learning is a dangerous thing. Bacteriology, unfortunately, suffers at the present time from the idea that it is essentially a popular science—that it is a subject well within the comprehension and well within the grasp of any one who chooses to hold out his hand for it. Thus we too frequently find it taken up by totally unqualified persons, and the results of their recondite researches serve to bring the whole domain of microbes into disrepute. We do not quarrel with Surgeon-Captain Leumann's little book, for it is clearly and concisely written, and makes every endeavour to be accurate and up to date; and of particular interest is the local colouring, if we may use such an expression, which characterises it in dealing with the most recent work in India on plague and cholera. We have no desire to depreciate these notes, but we do regret that the author encourages the practice of reading about bacteria instead of working at them in a class of professional men who ought certainly to be able to do something more substantial than talk about them. Bacteriology to be of any value must be studied in the laboratory; and without a practical acquaintance with micro-organisms, the latest and most exhaustive manual "made in Germany" will fail to do more than acquaint the reader with the superficial phraseology of the subject.

The Winter Meteorology of Egypt and its Influence on Disease. By H. E. Leigh Canney, M.D. (Lond.), &c. Pp. 72. (London: Baillière, Tindall, and Cox, 1897.)

TO people who, for health's sake, pass the winter in Egypt, and to practitioners who wish to know the climatic conditions of the various health resorts of the country, this book will be an invaluable possession. The volume comprises a paper read before the Royal Meteorological Society last December, and one read before the recent International Congress of Medicine at Moscow. The first of these papers contains the results of a series of meteorological observations made under precisely comparable conditions during three or four winters in Egypt. The stations at which observations were made were Cairo, Mena Honse, Helouan, Luxor, Assouan, Valley of the Tomb of the Kings, and the crest of the Libyan Hills. As self-recording thermometers and hair-hygrometers were used at each station, valuable data were obtained on the diurnal variation of temperature and humidity. It appears from the discussion of the observations that the climate of Egypt is influenced by the Libyan or Western Desert, the Mediterranean Sea, and the extent of cultivated land.

The second part of the treatise provides the medical profession with a valuable guide to the therapeutic influences of the climates of different health stations in Egypt. Practitioners who have not been able to visit the country will find this section most serviceable.

Appended to the volume are several clear and instructive diagrams showing, for the six months from November 1895 to April 1896, the temperature and relative humidity at various hours of the day at Helouan, Mena Honse,

Luxor, and Assouan; the drying power of the air at the temperature of the air; and the drying power of the air at the temperature of the body.

Les Fours Électriques et leurs Applications. By Ad. Minet. Pp. 178. (Paris: Gauthier-Villars et Fils; Masson et Cie.).

ALL thermo-electric effects in which electricity is the prime agent are regarded by the author as coming within the scope of the title of this book, the grounds being that all forms of apparatus for converting electrical energy into heat, come under the generic head of *fours électriques*. The book thus includes not only descriptions of electric furnaces in which temperatures approaching four thousand degrees are reached, but also of simple conductors and resistance coils raised a few degrees above the temperature of the atmosphere by the electric current. The first part of the volume is devoted to an account of the heating effects of electricity; it includes descriptions of the heat produced by a current passing through a metallic resistance, the maximum temperatures of conductors, and electric heating generally. The remaining three parts deal with the electric arc and arc-carbons of various forms, electric furnaces and their applications, and carbide of calcium and acetylene.

It will thus be seen that portions of the book are not exactly pertinent to the title, nevertheless they assist the reader to a clear understanding of electro-thermal phenomena. The section on electric furnaces is a concise account of the various forms of furnace devised for different purposes.

The book belongs to the Encyclopédie scientifique des Aide-Mémoire series edited by M. Léauté.

Bibliography of X-Ray Literature and Research (1896-1897); being a Ready Reference Index to the Literature on the Subject of Röntgen or X-Rays. Edited by Charles E. S. Phillips. With an Historical Retrospect, and a chapter of "Practical Hints." Pp. xxxvii + 68. (London: *The Electrician* Printing and Publishing Co., Ltd.)

THE work before us gives, in a handy and succinct form, a good deal of information respecting the literature of X-rays. The subject proper of the volume is prefaced by a brief historical retrospect, in which, however, the average worker in physics will find little but what is already known to him, and a short chapter of practical hints intended "to appeal more especially to physical students about to turn their attention to high vacua research." The main and most valuable portion of the book is the bibliography, and this should certainly prove of utility to investigators in this branch of science. The volume, so far as we have been able to test it, appears to have been compiled with great care, and certainly a mass of useful knowledge is here gathered together in a form easy of reference.

Die Meteoriten in Sammlungen und ihre Literatur, nebst einem Versuch den Tauschwert der Meteoriten zu bestimmen. Von Dr. E. A. Wülfing. Pp. xlvi + 460. (Tübingen: Laupp, 1897.)

THE author has sought information relative to the meteorite collections, public and private, from those in charge of them, and has collated and indexed the results in the form of an alphabetical list, giving for each preserved meteorite a statement of the date of fall or find, a list of the more important memoirs relating thereto, and the weights preserved in the various collections. The work has been carefully done, and will be very useful to collectors of these extra-terrestrial bodies. As regards the pecuniary values to be assigned to the meteorites, we are afraid that the dealers will eschew all such mathematical calculations as are suggested by the author, and will in each case get, as heretofore, what they can.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Rediscovery of the Tile-fish ("Lopholatilus").

I AM indebted to Dr. John Murray for drawing my attention to an error in the address which I had the honour of delivering before the Linnean Society on May 24. In referring to the discovery and subsequent remarkable disappearance of the Tile-fish (*Lopholatilus chamæleonticeps*), I stated that since the year in which the extraordinary mortality in this species had been observed (1882), "no specimen of the fish has ever been found."

I must take an early opportunity of correcting this error, which I might have easily avoided by reading more carefully the concluding paragraphs of Goode and Beane's account of the Tile-fish in "Oceanic Ichthyology," p. 288, from which I may be allowed to quote as follows:

"In the fall of 1892, Colonel Marshall McDonald, the Commissioner of Fisheries, made another attempt to discover the fish, and was successful, obtaining it from the following stations [five stations are enumerated, on which eight specimens were caught]. The Tile-fish then is restored to the list of existing species of our North Atlantic coast, and it is probable that in time it may attain to its former abundance. The temperature-investigations made by Colonel McDonald have been carefully discussed by him, and he is convinced that the destruction of *Lopholatilus* was due entirely to climatic causes."

What these climatic causes are we learn from a report by Prof. William Libbey, jun., published in the U.S. Fish Commission Report for 1893 (Washington, 1895, 8vo), p. 32; they consist in a variation of the relations of the Gulf Stream to the Labrador current, affecting the temperature of a certain area inhabited by the fish. A lowering of the temperature by the latter current is believed to have caused the sudden mortality, whilst a subsequent invasion of warm Gulf Stream water would allow the fish to gradually reoccupy the depopulated area.

Kew Gardens, November 14. A. GÜNTHER.

The Exploration of the Air by Means of Kites.

THE highest kite ascent, described in NATURE of October 7, was in turn exceeded here by more than 1800 feet on October 15, when excellent meteorological traces (of which a facsimile is enclosed) were brought down from a height of 11,086 feet above Blue Hill. The flight was effected with only four kites, and the ascent and descent occupied but four and a half hours. Excepting a more rapid decrease of temperature with increase of elevation, the results agree with those already stated for the previous high flight.

I now desire to call attention to the fact that the deductions from our automatic records obtained with kites seem to confirm, in general, the conclusions reached by Messrs. Welsh and Glaisher from their observations in free balloons many years ago in England. For example, we find also that the most rapid decrease of temperature with height occurs usually in the lower mile of air during the daytime, and, even with no visible clouds, that damp strata often exist in the dry air of the upper regions. A discussion by Mr. Clayton of more than one hundred meteorological records, obtained with kites since 1894, is now in the press, and will form an appendix to Part i. vol. xlii. of the *Annals of the Astronomical Observatory of Harvard College.*

A curious illustration of how identical methods sometimes may serve diametrically opposed investigations, is the application of the deep-sea sounding apparatus of Sir William Thomson (now Lord Kelvin) to bring *down* these aerial soundings.

A. LAWRENCE ROTCH.

Blue Hill Meteorological Observatory, November 1.

Lord Rayleigh's Proof of Van 't Hoff's Osmotic Theorem.

IN what follows I shall understand by "Van 't Hoff's Osmotic Theorem," the statement, that if P, V be the osmotic pressure and volume of unit mass of a solute, and p, v the gas-pressure and volume of the same mass of the same substance supposed gaseous at the same temperature, then $pv = PV$.

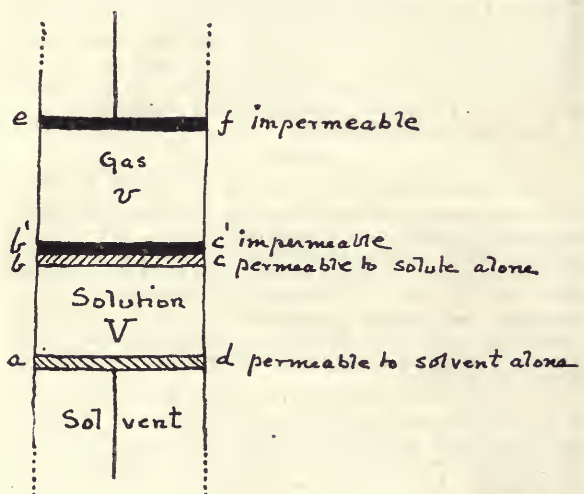
As is well known, this theorem was originally proved by Van 't Hoff by employing a differential thermodynamical process, which led to the result $vdp = VdP$. Assuming Henry's law in the form $\frac{v}{V}$ = const., and Boyle's law for both gas and solution, *i.e.* pv = const., and PV = const., the above result follows at once. Substantially the same proof was given by Nernst in his "Theoretische Chemie."

Quite recently, however, a new and novel proof of the same theorem was published by Lord Rayleigh in the columns of NATURE. In this proof Lord Rayleigh avoids the assumption of the equation PV = const., and herein lies a definite advance in the subject. The proof is based on the validity of Boyle's law for the gas, and Henry's law; but as the solvent is assumed to be involatile, it was objected by Lord Kelvin that the great majority of cases would thereby be excluded. So far as I can see, a small addition to Lord Rayleigh's proof will suffice to free it from this objection.

Besides this, I think that Lord Rayleigh's proof may be generalised so that even the assumption of Boyle's law for the gas is not required, at all events formally.

The primary assumption to be made is that for isothermal equilibrium the ratio of the concentrations of the substance in question, as gas and as solute, remains constant. This is usually known as the Distribution-Law, and cannot be regarded as a mere deduction from Boyle's law, and a certain form of statement of Henry's law. Recent research rather goes to show that it is a fundamental law of great generality. Accordingly I venture to employ Lord Rayleigh's method of proof, as follows.

ad and *ef* are two pistons, *ef* being impermeable, and *ad* permeable for the solvent alone. *bc* and *b'c'* are two fixed walls, of which *b'c'* is impermeable and *bc* permeable for the solute



only. The piston *ad* is for the present fixed, and encloses a volume V of solvent between itself and *bc*. Suppose the cylinder to have unit section, and denote height of upper piston above the fixed semi-permeable wall by x. The whole process is conducted at the constant temperature t. Suppose now that between *ef* and *b'c'* there is enclosed a quantity of the solute as gas, of volume v, temperature t and pressure p, the amount being so chosen that it is just sufficient to saturate the volume V of solvent at this temperature and pressure. Let ρ denote density of the gas and suppose $p = \rho^2\phi'(\rho)$ to be the isothermal equation of state for the gas, where ϕ is an undetermined function. Take as unit of mass the mass of the enclosed gas. Allow the upper piston to rise reversibly to a height x, which is a very great multiple of the initial height. The work done in this process is:—

$$\int_v^x pdv = \phi\left(\frac{1}{v}\right) - \phi\left(\frac{1}{x}\right).$$

Let *b'c'* be removed and the gas reversibly compressed, whereby it is reversibly absorbed, the small amount of irreversibility at the beginning becoming vanishingly small in the limit. Denoting by c the concentration of the solution at any moment, we have during the downward stroke:—

$$\rho x + cV = 1$$
$$\frac{c}{\rho} = \text{K (Distribution-Law).}$$

The work done on the system in this stroke, whereby the gas is just completely absorbed, is given by:—

$$\int_0^x pdv = \Big[\phi(\rho)\Big]_{x=x}^{x=0}$$
$$= \phi\left(\frac{1}{\text{KV}}\right) - \phi\left(\frac{1}{x+\text{KV}}\right).$$

But $\frac{1}{\text{KV}} = \frac{1}{v}$, since by hypothesis $\frac{1}{V}$ and $\frac{1}{v}$ are the concentrations of the substance in solution and as gas respectively, for equilibrium at t and p. Thus the work done so far by the system is:—

$$\phi\left(\frac{1}{x+\text{KV}}\right) - \phi\left(\frac{1}{x}\right)$$

where x is indefinitely great.

Separate gas and solvent now, working both pistons so as to keep the concentrations constant, and thus arrive at the initial state, whereby in this portion of the process the system does work $pv - \text{PV}$.

Since the net work obtainable in a reversible isothermal cycle is zero, we have finally:—

$$pv - \text{PV} + \text{L}t_{x=\infty}\left[\phi\left(\frac{1}{x+\text{KV}}\right) - \phi\left(\frac{1}{x}\right)\right] = 0.$$

Now the term in brackets is zero if $\phi(z)$ has the form log z or any positive power of z, so that it vanishes if $\phi(z)$ has the form $a \log z + b_0 + b_1 z + b_2 z^2 +$ &c. Hence it vanishes if $\phi'(z)$ has the form $\frac{a}{z} + b_0 + b_1 z + b_2 z^2 +$ &c., since the latter series is by hypothesis convergent.

That is to say, pv = PV if the isothermal equation of state is—

$$p = \rho^2\left(\frac{a}{\rho} + b_0 + b_1\rho + b_2\rho^2 + \text{\&c.}\right),$$

or

$$p = a\rho + b_0\rho^2 + b_1\rho^3 + b_2\rho^4 + \ldots$$

This includes the equations of Boyle and Van der Waals as special cases.

The equation $pv = \text{PV}$ is thus a formal consequence of the distribution-law and the expressibility of p as an infinite power series of ρ. However, when Boyle's law does not hold, this result loses much of its significance, as it does not then lead to an equation of state for the solution. So that this slight extension of Lord Rayleigh's result is not perhaps of much practical use.

Holywood, Co. Down. F. G. DONNAN.

The Law of Divisibility.

WITH respect to Mr. Burgess's letter in your issue of November 4, perhaps the following general rule for testing the divisibility of a given number by another, which I found some days ago, may be of some interest.

Any number

$$Z = a_n \cdot 10^n + a_{n-1}10^{n-1} + \ldots + a_\nu 10^\nu + \ldots + a_1 \cdot 10 + a_0$$

is divisible by another number N when the sum

$$\sum_{\nu=0}^{\nu=n-\alpha+1}(a_{\nu-\alpha+1} \cdot 10^{\alpha-1} + \ldots + a_\nu)(10^\alpha - \text{N})^{\frac{\nu}{\alpha}}$$

can be divided by N without residue; otherwise the residue of this division is equal to the residue of the division Z : N.

Of course, from $(10^\alpha - \text{N})^{\frac{\nu}{\alpha}}$ the nearest multiple of N must be subtracted.

Examples: (1) N = 7. Take $\alpha = 1$; then $10^\alpha - \text{N} = 3$, and Z is a multiple of 7 when $a_0 + 3a_1 + 2a_2 - a_3 - 3a_4 - 2a_5 + \ldots$ is divisible by 7.

(2) $N = 11$. $\alpha = 1$ $10^\alpha - N = -1$; hence Z is a multiple of 11 when $a_0 - a_1 + a_2 - a_3 + a_4 - + \ldots$ is a multiple of this number.

(3) $N = 103$. If we take $\alpha = 2$, we get $10^\alpha - N = -3$, and Z will be a multiple of 103 when

$$(a_0 + 10a_1) - 3(a_2 + 10a_3) + 9(a_4 + 10a_5) - 27(a_6 + 10a_7) + 81(a_8 + 10a_9) - 37(a_{10} + 10a_{11}) + - \ldots$$

can be divided by 103 without residue.

To take a numerical example, try if 298744898 is a multiple of 103, and determine the residue if it is not.

We get

$$98 - 3 \times 48 + 9 \times 74 - 27 \times 98 + 81 \times 2 = -1864;\ 19 \times 103 = 1957;\ \text{therefore residue} = 1957 - 1864 = 93,$$

which will be found correct by performing the division.

I have no doubt the above rule will be well known to mathematicians, but not being much acquainted with the theory of numbers, I cannot at present tell where it may be found; the proof is very easy.

C. BÖRGEN.

Wilhelmshaven, November 7.

THE examples given by Dr. Börgen, in his interesting communication, fall under suggestions (2) and (6) in my second letter, where if $\delta = 7$ the period $\pm 1, 3, 2$ may be used; or if $\delta = 11$ the period ± 1 is available; or if $\delta = 103$ take

$$\delta_1 = \delta - a = 103 - 3$$

giving the rule—

Divide N into dual periods beginning from the units place; multiply each by $(-a)^n$, giving to n the successive values 0, 1, 2, 3 &c.; the sum of these positive and negative products is N_1.

I may add, this rule applies to $\delta = 17, 101, 103, 107, 109$, taking $a = -(2, 1, 3, 7, 9)$, or to $\delta = 19$ if $a = 5$, but if $\delta = 83$, N must be divided into triple periods, a being $+4$.

HENRY T. BURGESS.

Tarporley, West Norwood, November 11.

HON. RALPH ABERCROMBY.

RALPH ABERCROMBY was born in 1842, and was the youngest son of the third Lord Abercromby. His mother was a daughter of Lord Medwyn, a Lord of Session in Edinburgh. Several of his immediate relatives had been eminently distinguished. His great-grandfather, Sir Ralph Abercromby, who died in 1801, in the moment of victory, at the Battle of Alexandria, had served his country with brilliant distinction, in the West Indies (Trinidad) and at the Helder.

As soon as the news of Sir Ralph's death reached England, and in commemoration of his services, a barony was conferred upon his widow, with remainder to his sons.

Of these sons the second became Sir John. He was in the service of the East India Company, and took the Island of Mauritius in 1810. Another was Speaker of the House of Commons in 1835, and was created Lord Dunfermline.

Ralph was never robust, even as a boy. He went to Harrow, and soon was obliged, owing to delicacy, to leave the school. He had, however, shown signs of great promise by taking a double remove after his first term.

In June 1860 he was gazetted to the 60th Rifles, and four years later obtained his lieutenancy and joined the Fourth Battalion at Quebec.

The War of Secession was then at its height. Abercromby obtained leave and visited the scene of action. He took with him letters to General Grant, and was well received, but he did not happen to be present at any of the great battles.

At the beginning of 1866 he entered the Staff College, having passed in without "cramming," but his health soon broke down there. Two visits to Kreuznach produced no benefit, and in 1869, to his great regret, he felt himself obliged to give up his commission.

In later years he twice was sent on a voyage round the world, in hopes of restoration to health; and it was in the beginning of 1890, at the commencement of a third voyage to the Pacific, that he was taken ill at Sydney—an illness which terminated fatally June 21, 1897. He passed away quietly in his sleep.

Abercromby had, from a very early period, paid much attention to observational meteorology. In his "Seas and Skies in many Latitudes," observations are recorded which he must have made during his military service in Canada. His name will live longest in connection with the new classification of clouds which he, in conjunction with Prof. Hildebrandsson, of Upsala, proposed, and which was adopted by a majority of votes at the International Meteorological Conference of Paris in September 1896.

His published books were: "Principles of Forecasting by means of Weather Charts," 1885, published by authority of the Meteorological Council; "Weather, a Popular Exposition of the Nature of Weather Changes," 1887 (International Scientific Series); "Seas and Skies in many Latitudes," 1888. In addition he brought out many papers which appeared in various journals and periodicals, such as the *Proceedings* of the Royal Society, the *Journals* of the Royal and of the Scottish Meteorological Societies, as well as in NATURE, *Good Words*, &c.

Fifteen papers are down to his name between 1873 and 1884 in the Royal Society Catalogue of Scientific Literature.

From his sick bed in Sydney he showed his great interest in the advancement of the science by making grants of money for the production of essays on meteorological subjects. Three of these have been published: "On Moving Anticyclones in the Southern Hemisphere," "On Southerly Bursters," and "On Types of Australian Weather."

Abercromby retained to the very last the power of making and keeping friends. This was in great measure due to his loyal and affectionate nature, which neither distance nor illness could impair. Those who were with him during his last suffering months bear witness to the patience and gentleness, which were as conspicuous under the trials of severe pain as they had been when he was in full possession of his faculties.

His lot was indeed a hard one. He had first to bear the heavy disappointment of enforced resignation of a profession which he loved, and in which his prospects seemed so brilliant, and then he had to sustain the strain of more than twenty years of impaired and gradually failing health.

He leaves behind him the memory of a warm unselfish friend, cut off in a distant land, far from his kith and kin.

R. H. SCOTT.

REV. SAMUEL HAUGHTON, M.D.

THE announcement of the death of Dr. Haughton has been received with the deepest regret in various scientific circles, and by his numerous personal friends and acquaintance attracted to him by his sturdy honesty, unselfishness, and geniality of disposition. He was born in Carlow in 1821. After a distinguished undergraduate career in Trinity College, Dublin, he was elected Fellow thereof in 1844. He held the Professorship of Geology from 1851 to 1881, in which latter year he was co-opted Senior Fellow of the College. He was admitted F.R.S. in 1858. The Universities of Oxford, Cambridge, and Edinburgh signified their appreciation of his merits by conferring on him the honorary degrees of D.C.L. and LL.D., respectively. Having taken the degree of M.D. in his own University in 1862, he was made Registrar of the Medical School there, and applied himself with his usual energy and activity to the reorganisation of that School; thereby raising it to its present condition of high efficiency. He was elected a Governor of Sir Patrick Dun's Hospital, which is connected with the

University, and there made his presence as beneficially felt in the management of the institution as it was in that of the School. We may take this opportunity of noting that, as the result of his experience in such work, he wrote many papers on medical subjects in various publications, and that the honorary degree of M.D. was conferred upon him by the University of Bologna. He represented the University of Dublin on the General Medical Council, from 1878 to 1896, and took a prominent and useful part in the proceedings of that body. Dr. Haughton displayed remarkable versatility of intellect. The record of his scientific work is to be found principally in his numerous papers in the publications of various scientific societies, and in scientific periodicals. We may instance those of the Royal Society, the Royal Irish Academy, the Geological Society of London (of which he was a Fellow) and that of Ireland, the Royal Dublin Society, the *Cambridge and Dublin Mathematical Journal*, NATURE, the *Philosophical Magazine*, the *Natural History Review*, the *American Journal of Science*, the British Association, &c. Among the great variety of subjects treated we may mention his discussion and calculation of the tides in the Arctic seas from the observations of voyagers, and also of the tides round the coast of Ireland, founded upon observations made under the direction of the Royal Irish Academy. He paid much attention to the granites of Ireland. A favourite subject with him was animal mechanics. It might have been better for his future name, though perhaps not for science in general, if he had bestowed his powers more on the production of *treatises* on fewer subjects. His work on the "Principles of Animal Mechanics" (London, 1873) makes us feel this. That book was the outcome of observations, experiments, and calculation extending over several years. It includes results published in various papers on different parts of the subject, contributed to the Royal Society and the Royal Irish Academy, and in lectures delivered by him before the Royal Institution in London. The important "Principle of Least Action" is brought frequently into view in his discussion of various details of the vertebrate muscular economy. A complaint, which, however, is unavoidable in this case, has been brought against this book; viz. that many anatomists would not be able to follow the mathematics, and many mathematicians would not have sufficient command of the anatomical points, there presented. His "Lectures on Physical Geography," 1880, printed in the Dublin University Press Series, are marked by his usual power and originality. We shall only allude to his "Manual of Geology," and to the numerous books on elementary science written by him and Prof. Galbraith in conjunction, some of which have had a large circulation. Trinity College, Dublin, will long mourn the vacancy left by him as a gifted son, an able administrator, and an active participator in her work of teaching. The Royal Irish Academy will feel his loss to a very special degree. He joined that body in 1845, and contributed to it most of his principal scientific papers. The Academy presented to him its Cunningham Medal, in 1848, for his "Memoir on the Equilibrium and Motion of Solid and Fluid Bodies." He was for many years a most valued member of its Council, and was President of it from 1886 to 1891. We must not forget to mention that he was for just twenty years the efficient Secretary of the Royal Zoological Society of Ireland with its Zoological Gardens, at a time when the finances of the Society were in a less satisfactory condition than at present, and it is acknowledged that, on more than one occasion, he was the means of saving the Society from shipwreck by his energy and resource. It is very rarely indeed that we meet with a man of so remarkable an individuality, and endowed with such varied powers of working in both practical and scientific lines of usefulness. C.

NOTES.

At a meeting of the general committee of the British Association recently held, Sir W. Crookes, F.R.S., was elected President for 1898. It was decided that the meeting in Bristol shall open on September 7, 1898.

The Executive Committee of the International Congress of Zoology, which, as has already been announced, will be held at Cambridge in August next, has recently been appointed, and is composed as follows:—President, Sir John Lubbock; Vice-Presidents, the Vice-Chancellor of the University of Cambridge, Dr. W. T. Blanford, Sir W. H. Flower, the President of the Linnean Society, Prof. Ray Lankester, Prof. A. Newton, Dr. P. L. Sclater, the President of the Entomological Society, Sir William Turner, and Lord Walsingham; Treasurers, Prof. S. J. Hickson and Dr. Sclater; Secretaries, Prof. F. Jeffrey Bell, Mr. G. C. Bourne, and Mr. A. Sedgwick; Ordinary Members, Dr. Gadow, Mr. F. D. Godman, Lieut.-Colonel Godwin-Austen, Sir G. F. Hampson, Dr. S. F. Harmer, Prof. Howes, the Hon. W. Rothschild, Mr. H. Saunders, Prof. Seeley, Dr. D. Sharp, Mr. A. E. Shipley, Prof. C. Stewart, and Dr. H. Woodward. The official address of the Congress is, by the courtesy of the Zoological Society, 3 Hanover Square, London, W.

The interesting ceremony took place on Monday afternoon last, at the Michael Faraday Board School, Faraday Street, Walworth, of unveiling a bust of Michael Faraday. The bust, which is of white marble, was presented to the school by the managers of the Royal Institution of Great Britain, and is a copy of the original bust executed by Matthew Noble. It stands upon a pedestal of Aberdeen granite four feet in height, and has been placed in the boys' hall of the school. On the wall immediately behind the bust a large brass tablet has been affixed, bearing the following inscription:—"Michael Faraday, natural philosopher, D.C.L., F.R.S., born at Newington, Surrey, September 22, 1791. He was a patient student, an eloquent expounder, and a brilliant illustrator of the laws of nature. Fullerian Professor of Chemistry in the Royal Institution of Great Britain, 1833 to 1867. Faraday's noblest monument is his 'Experimental Researches in Electricity and Magnetism' from 1831 to 1851. He died at Hampton Court Green, August 25, 1867, and was interred in Highgate Cemetery." Sir J. Crichton Browne, F.R.S., unveiled the bust, and expressed his pleasure at being permitted to unveil this statue of a great man who had spent a long life in unveiling the hidden mysteries of nature. He hoped the sight of that bust would be an inspiration to the children, and that they would learn who Faraday was and what he did. He suggested that one day every year should be set apart in the school in memory of Faraday, when some part of his work should be explained.

Prof. Oliver Lodge will deliver the first of a course of six Christmas lectures (specially adapted to young people) on "The Principles of the Electric Telegraph," at the Royal Institution on December 28. The remaining lectures will be given on December 30, 1897, and January 1, 4, 6, 8, 1898.

The Jubilee Medal has been presented to Sir Robert Ball, the President of the Royal Astronomical Society.

The Copenhagen correspondent of the *Times* states that an expedition to the Pamir regions will be fitted out next year. Its object will be to make geographical and ethnographical explorations in the northern part of the Wakhan valley. The expedition will be under the leadership of Lieut. Olufsen, and will include two scientific experts. Its cost will be partly borne by the Danish Government out of the Carlsberg fund, and the explorers expect to be absent for two years.

Science announces that the Austrian steamship *Pola* has again gone to the Red Sea for scientific explorations, and will this year cover the ground between Dschedda and Aden. Dr. Franz Steindachner, the ichthyologist, has charge of the zoological work, and observations will also be made in physical oceanography.

THE meeting of the American Psychological Association will be held this year at Cornell University, Ithaca, under the presidency of Prof. Baldwin, the sessions beginning on December 28.

ACCORDING to the Allahabad *Pioneer Mail*, the Ceylon Survey Department is about to start on a cadastral survey of the Crown lands and lands of doubtful ownership in the island, on a scale of ten inches to the mile, and a topographical survey on a scale of one inch to the mile. It is estimated that the cadastral survey will occupy the ordinary staff for about twenty-five years. The triangulation and topographical survey, which will embrace the whole island, will, it is expected, be completed in five or six years. It is stated that at the present time there is no trustworthy map of Ceylon in existence; that there is no contour map of the island of any description, and that the present so-called map is a compilation from Colonel Fraser's map (now nearly 100 years old), and contains errors so numerous and gross as to make it useless. Hence the new surveys to which reference is made.

THE Indian Section of the Pasteur International Memorial Fund has just forwarded a further contribution to the above of 17*l*. 3*s*. 6*d*., bringing the total amount subscribed in India up to the handsome sum of 460*l*. In a letter to Prof. Percy Frankland, F.R.S., Surgeon Major-General Cleghorn mentions that "the original subscription list contains the names of a goodly number of natives who have subscribed small sums."

WE are glad to notice that Surgeon-Major A. M. Davis is to be attached to the office of the Principal Medical Officer in India, as a tentative measure, for one year, for the purpose of carrying out bacteriological and sanitary investigations. We hope the office of bacteriologist and sanitary investigator will soon be a permanent one. It is also stated that the Madras Government has applied to the supreme Government for the appointment of a bacteriologist, and has received a sympathetic answer, the suggestion of the Government of India being that the present Professor of Hygiene at the Medical College should be appointed Professor of Bacteriology.

FURTHER particulars of the arrangements for the forthcoming meeting of the Australasian Association have reached us. Sir James Hector, the president of the geographical section, has announced as the probable subject of his presidential address—"Submarine Geography," and that the title of his popular lecture will be "Antarctica and the Islands of the Far South." A lecture to working men will be given by Prof. Threlfall and Mr. J. A. Pollock, who will speak on "Electric Signalling without Wires." The following papers, in addition to those already noted in NATURE, have been promised:—"On the Magnetic Force, at Right Angles to the Axis in the Interior of Solenoids," by C. Coleridge Farr; "The Work of High Level Stations in Australasia, with special reference to Mount Kosciusko and Mount Wellington," by Clement L. Wragge; "Milk Analysis in its relation to the Butter and Cheese Industries," by H. W. Potts; "Suggestions for a New Classification of the Eucalyptus," by Prof. Ralph Tate; "On the Occurrence of *Eucalyptus pulveruleata* in Victoria," by A. W. Howitt; "Notes on the Flora of the Mallee Districts of Victoria," by St. Elroy D'Alton; "On the Growth of Galls and Gall Insects," by W. W. Froggatt; "Notes on the Disappearance of Native Races in general, and of Fijians in particular," by H. H. Thiele; "The Colour of Flowers, and its Influence on Bee Life," by Albert Gale; "Notes on the Wax of *Ceroplastes rubens*," and "On the Colouring Matter of *Eris cocci eucalypti*," by E. H. Gurney. A long list of excursions has been prepared, and at a recent meeting of the Council it was unanimously decided that scientific societies in other colonies should be invited to send non-resident delegates to the Sydney session; and that members of the British, American and foreign associations, non-resident in Australasia, who attend, should be admitted free.

THE following science lectures will be delivered at the Imperial Institute on the dates mentioned:—On November 19, "Three Years in the Arctic," by Mr. F. G. Jackson; on November 22, "Electric Balloon Signalling applied to Scientific Exploration in Arctic and Antarctic Expeditions," by Mr. Eric Bruce; on November 29, "The Wild Kafirs of the Hindu Kush," by Sir G. S. Robertson; on December 6, "The Mineral Resources of British Columbia and the Yukon," by Mr. A. J. McMillan; on December 13, "Canada's Metals," by Prof. W. C. Roberts-Austen; on December 20, "The Petroleum Sources of the British Empire," by Mr. Boverton Redwood.

THE International Congress on the Protection of Birds, opened at Aix-en-Provence on November 9, and arranged by the Ligue Ornithophile Française, of which M. Louis-Adrien Levat is the president, was concluded on Saturday last. The protection of insectivorous birds useful to agriculture was the chief matter discussed, and it was decided to forward to the Governments of Europe, through the French Minister of Foreign Affairs, the resolutions which were formulated. Public educational bodies are also to be approached in order to obtain, if possible, the serious consideration of this important subject by schoolmasters and Government school inspectors. Numerous French and Italian agricultural, horticultural, and sporting societies were represented at the Congress, and delegates from the Selborne Society and the Society for the Protection of Birds were also present.

THE late Mr. W. Bolitho of Penzance, for thirty-five years treasurer of the Royal Geological Society of Cornwall, bequeathed 500*l*. to the trustees of that Society, the yearly income accruing from which was to be applied to the purchase of a gold medal, "to be called the William Bolitho Medal, to be awarded to such member of the said Society, whether Ordinary, Honorary, or Associate, whose attainments, labours, and discoveries in Geological or Mineralogical Science shall, in the opinion of the President and Council of the said Society, best deserve recognition." The first award of this medal was made in November, 1896, to Prof. Robert Etheridge, in recognition of "his age, his great attainments, and his life-long labours for the benefit of science." The second award was made on the 9th inst. to Mr. Howard Fox, of Falmouth, in recognition of his various discoveries in the field geology of Cornwall, and of his having brought to light the radiolarian beds of the south-west of England.

THE *Electrical World* (New York) states that the National Museum at Washington has just been enriched by a very valuable and interesting collection, comprising the private papers of the late Mr. Cyrus W. Field relating to the laying of the first Atlantic cable, cable despatches first sent, objects with which Mr Field worked out the idea of laying the cable, and many other things of interest pertaining to the project. The correspondence and autograph copies of telegrams sent by Mr. Field to the President of the United States and other eminent persons are included. The globe, which was constructed in London, and on which Mr. Field traced the course of the cable

to be laid from Newfoundland to Ireland, forms an attractive object of the collection. It is about 18 inches in diameter, on a stand, with a magnetic compass underneath, and shows many signs of hard usage. The journal kept by Mr. Field and notes of deep-sea soundings set down by him and officers of the *Great Eastern*, which laid the cable, are part of the collection. Mr. Field's private library, with all the literature relating to the work of laying the cable, forms another part. There are also copies of medals presented to Mr. Field by Congress and the French Government, engrossed resolutions passed by public bodies in the United States and in Europe, a cane from the wood of the *Great Eastern*, &c., as well as cases containing sections of the first Atlantic cable.

THE Paris correspondent of the *Times* gives particulars of the trial trip at Mantes of the electric locomotive devised by M. Heilmann. The train, which was composed of twelve carriages and a luggage van, and carried 250 persons, weighed about 150 tons. The object of the trip was not to make a trial of speed, and the train journeyed at the rate of only eighteen miles an hour; the experiment seems, however, to have been considered a great success, and testimony is borne to the ease and regularity of the movement of the train. Great things are hoped from this invention, no less than the conveying of a train weighing 300 tons at the speed of sixty-two miles an hour being looked forward to. The Heilmann engine draws a closed tender containing a steam engine of the Pilon pattern, which works the dynamos producing electricity. The motive power is transmitted directly to the eight wheels, which are only one metre five centimetres in diameter. The consumption of coal by the engine is less than that of an ordinary engine, so that the locomotive can go greater distances with fewer and shorter stops for replenishing coal and water. It will, of course, light up the carriages by electricity, and it is thought that the electric will supersede the air brake.

A LECTURE on "Microscopic Observations on Deterioration by Fatigue in Steel Rails," was given on Monday, the 8th inst., before the Sheffield Society of Engineers and Metallurgists, by Mr. Thomas Andrews, and is reported in the *Sheffield Daily Telegraph*, from which we give a condensed report as follows:—The earlier part of the lecture was occupied with the consideration of the external stress and disintegrating forces imposed on rails, and a large number of illustrations of the state of the wearing faces of rails which had endured the stress of wear for known periods and under known conditions of main line service were given. The gradual development of lines of transverse weakness, indicating the danger from minute cracks, and showing the influences of internal micro flaws in assisting the loss of strength due to vibratory stress were then traced. The effects also of varied chemical compositions on the physical properties and strength of steel rails were also considered, and illustrated by numerous micro-sections and micrographs. The lecturer referred to his recent researches on another serious cause of the loss of strength in rails arising from occasional segregation of the chemical constituents and impurities in steel rails, and offered suggestions for the prevention of this evil. He further referred to the light thrown on this question by recent microscopic researches on the structure of gold and other metallic alloys. The effects of the secondary crystallisation of iron recently observed by the lecturer were also illustrated. Reasoning from the results of his research on the microscopic structure, chemical composition, and physical structure of rails of satisfactory long life, Mr. Andrews indicated the conclusions he had arrived at as to the specification for modern rails best calculated to ensure durability and safety for main line services. The lecturer mentioned that he was still pursuing additional chemical, physical, and microscopical researches on the important question on the loss of strength in steel rails by reason of use, and expressed the hope that valuable results in the interests of the public safety would result.

AT a meeting of the Nottingham Naturalists' Society on November 9, the newly-elected president, the Rev. A. Thornley, delivered a thoughtful address on "The Work of a Natural History Society." In the opinion of the president, the functions of a Society such as theirs should embrace at least the following objects: instruction, stimulation, field-work, and protection. The speaker, in the course of his remarks, regretted that the study of entomology has up to the present been to a large extent neglected in the county of Nottingham, but stated there were signs of improvement in this direction, as during the past year their Coleoptera list had been largely augmented by the labours of several members of their Society.

THE so-called "fruit cure," although not much heard of in this country, is well recognised at various places on the continent, where so-called grape-cure stations have been established. In a recent number of *Modern Medicine and Bacteriological Review* there is an interesting article on the subject, in which the historical side of the question is dealt with. Thus we are told that many medical authorities in the tenth century become enthusiastic in their writings over the remarkable curative virtues of grapes, whilst a certain Van Swieten, of a more modern date, is said to have "recommended in special cases the eating of twenty pounds of strawberries a day." The same gentleman also reports a case of phthisis healed by strawberries, and cites cases in which maniacs have regained their reason by the exclusive use of cherries as food! These instances rather savour of the miraculous; but there is no doubt that the so-called grape-cure, for indigestion and other evils, is carried on in many places on the continent, and that people betake themselves to Meran, Vevey, Bingen, or to Italy and the South of France with the intention of devoting six weeks to the cure, during which time they are expected to have gradually accomplished the feat of consuming from three to eight pounds of grapes daily as the case may be. Grapes are said to exercise a salutary action on the nervous system and to favour the formation of fat, that is to say, when fruit of good quality is employed; if the grapes are not sufficiently ripe, and are watery and sour, the patient may lose rather than gain in weight. Dr. Kellogg, Director of the Sanitarium Hospital and Laboratory of Hygiene at Battle Creek, Mich., is of opinion that the valuable results obtained by a fruit diet in cases of biliousness which he has observed are due to the fact that noxious germs habitually present in the alimentary canal do not thrive in fruit juices.

THE Board of Trade report for 1897 on the sight tests used in the mercantile marine shows that of the fifty-six candidates who failed in colour vision in 1896 twelve were examined on appeal, of whom five passed and seven were rejected. The number of officers already in possession of certificates who, on coming up for examination in 1896, failed to pass the sight tests, was twelve—one master, five mates, and two second mates failing in colour vision, and one mate and three second mates failing in form vision. Two of the mates who failed in colour vision appealed and passed, and one of the second mates who failed in form vision passed on re-examination. The percentage of failures to pass the colour tests was 1·02, a percentage almost exactly the same as that obtained in former years, before the introduction of the wool test. The most extraordinary point in the report is the great number of normal sighted persons who were rejected as colour blind; no less than 41·6 per cent. of those who appealed passed. This state of things, says the *British Medical Journal*, we may expect to continue until properly qualified medical men are employed as examiners, and a trustworthy test is used.

THE Königsberg and Memel district of East Prussia is known to be a district in which ophthalmia is prevalent. According to the *British Medical Journal* a careful examination of the eyes of all children in schools at Königsberg has just been carried out by twenty-seven doctors, the result showing that 32 per cent. of the children are suffering from ophthalmia, and of these more than a third from granular lids.

FROM the U.S. *Monthly Weather Review* for August we learn that the Postal Telegraph Cable Company is co-operating with the United States Time and Weather Service Company of New York in establishing throughout the city a number of handsome clocks which shall exhibit standard time, not only by the face of the clock, but by the dropping of a time-ball at noon. Under the dials are panels, which are filled up partly by special advertisements, and partly by the latest Weather Bureau reports and forecasts, which are thus made known two or three hours before they appear in the afternoon papers. The stands contain, in addition, a barometer and thermometer. The clocks have also been erected in many western cities, and the arrangement is somewhat similar to the so-called Urania Columns in Berlin, where they are said to be very popular.

THE *Indian Daily News* for October 23 contains a preliminary note on the Calcutta earthquake of June 12, by Prof. F. Omori, who has been making investigations on behalf of the Japanese Government. One peculiarity of the earthquake is that, notwithstanding its vast area of disturbance, the motion on the surface was not extremely violent. The variation of the intensity of the shock along lines across the seismic area was very gradual, and from this Prof. Omori infers that the depth of the seismic focus was not less than twenty miles. The shock appears to have been strongest at Shillong, Cheerapoonjee, and the neighbouring district. At Shillong the acceleration was calculated from overturned bodies to be about 8 feet per sec. per sec.; and this, if the period of vibration were one second, would imply a range of motion (or double amplitude) of about 5 inches. Prof. Omori believes that the origin of the earthquake was a sudden splitting asunder of the strata at a great depth, caused by an injection of steam or gas into cracks in the earth's crust. The seismic focus was situated in an east and west direction under the Garo and Khasi Hills, and to the west or north-west of the centre of the great Cachar earthquake of 1869.

A NEW form of electric seismoscope is described by Dr. G. Agamennone in the last *Bollettino* of the Italian Seismological Society, the chief merits claimed for it by its inventor being its comparatively slight cost (about thirty francs) and its great sensitiveness. In most seismoscopes the movement of a pendulum is magnified by a long pointer, whose tip just passes through a hole in a metal plate, contact with which completes an electric circuit and starts a clock previously set at twelve. In the new instrument the metal plate is not, as usual, fixed, but is connected with a second inverted pendulum, the bob of which is near the top of its supporting rod, while that of the first is near the base.

WE have received from the Imperial Observatory of Constantinople the monthly bulletins for January and February of the present year. They contain a brief meteorological summary, and continue, though apparently in less detail, the valuable lists of earthquakes issued for the years 1895 and 1896 by Dr. Agamennone. Both parts are the work of the Director, M. Salik Zéky.

AN automatic controller, intended for checking the issue of tickets in a railway booking-office, has been recently exhibited in London. The machine, which is of Belgian origin, is so arranged that each ticket is printed as issued. By two movements the clerk prints on the ticket the name of the issuing office, the destination of the passenger, the class, number, month, day, and hour of issue, and the serial number of the ticket. At the same time a record of the issue is printed on a slip of paper, which is inaccessible to the issuing clerk, and serves for making up the books at the end of the day, or other convenient opportunity. The names of the stations are arranged round the edge of a disc forming part of the machine, and in issuing a ticket, the clerk sets the name of the station required opposite a fixed mark. A downward movement of a small handle, of which there are a number corresponding to the different classes, causes an electric motor to do the necessary printing and eject the printed ticket from the machine. It is stated that each machine can be made to suit any number of stations up to 100. Where a larger number have to be dealt with, extra machines would be employed. A practical trial of the instrument, is, we understand, to be made on the Northern Railway of France in connection with the suburban service. Where large numbers of stations have to be dealt with, the inventor proposes to modify the arrangement of his machine by fitting it with keys like a typewriter, the depression of any one of which will cause the printing of a ticket for the corresponding station. In this way a possible loss of time in selecting the proper station from the rim of the disc previously referred to will be avoided. The machine, as made for twenty stations, is about 5 feet 8 inches high, and has a base 18 inches square.

THE U.S. Pilot Chart of the North Pacific Ocean for the present month contains, among other useful information, a description of the storm-warning signals employed by the various maritime nations. In looking over this list one is struck by the great success of the system of drum and cone signals introduced in this country in the year 1861 by Admiral FitzRoy, the first chief of the Meteorological Office, as these have been adopted, in either their original or somewhat modified form, in every European country in which storm signals are used except Portugal, which uses flags only; while in France, Germany and the Netherlands the cones or drums are supplemented by the use of flags or balls. They are also used in India and Japan in conjunction with balls, while flags or balls (only) are used in China and in North and South America. Prior to their introduction by Admiral FitzRoy, no signals to give notice of possible atmospherical disturbances were employed except in Holland, where there was a kind of semaphore, showing the difference of barometric readings between two places, from which one's own conclusions could be drawn as to the probability of approaching bad weather.

WITH the notable exception of M. Pénaud, most experimenters on mechanical flight have worked with fixed aeroplanes driven by a screw-propeller. A somewhat new departure has been made by Major R. F. Moore, who has selected the Indian flying-fox (*Pteropus edulis*) as his pattern on which to construct models. From his experiments, which are described in the *Aeronautical Journal*, Major Moore concludes that artificial wings can be constructed in imitation of those of the flying-fox, and that the action of the pectoral muscles can be reproduced by spiral springs of suitable strength to hold the wings expanded, the up and down motion being accomplished by means of a light electric or other motor. Two or more pairs of wings, arranged tandem fashion, are found to be better than a single pair—a result fully in accordance with the conclusions formed by other observers. Major Moore considers it quite possible to construct a machine of this type capable of raising a man.

ONE of the most remarkable papers read at the recent annual meeting of the Botanical Society of America in Toronto was on the discovery of antherozoids in *Zamia*, by Mr. H. J. Webber. The paper has been printed at length in the *Botanical Gazette*, and, after the discovery of a similar mode of fertilisation in *Cycas*

and *Salisburia*, will attract great attention. In *Zamia integrifolia* Mr. Webber states that there are formed, within the pollen-tube, near its basal end, two cells, one in advance of the other. From each of the cells thus formed is developed a motile antherozoid, two to each pollen-tube. They are of a much larger size than any known in vascular cryptogams, quite visible to the naked eye, and resemble in general structure those of ferns. The mature antherozoid passes into the archegone through an opening at the apex of the pollen-tube, and the fluid in which it swims about is supplied by the watery contents of the pollen-tube. The nucleus of the antherozoid is very large, and is surrounded on all sides by a thin layer of cytoplasm. The antherozoids rotate, the cilia continuing to oscillate for a considerable period after the rotation has ceased.

The *American Naturalist* for October contains a short memoir and a photograph of Mr. J. E. Humphrey, the botanist, whose untimely death from malarial fever while on a scientific expedition to Jamaica we recently recorded. Born in 1861, at Weymouth, Mass., he took up the study of botany from his student-days. Immediately after graduation he was appointed assistant in the botanical laboratory at Harvard, under Prof. Goodale. In 1887 he was selected as instructor in botany in the University of Indiana, and in 1888 botanist to the State Agricultural Experiment Station at Amherst, Mass. From 1892 to 1894 he studied under Prof. Strasburger at Bonn, and on his return was appointed lecturer on botany to the Johns Hopkins University at Baltimore. His best-known work was in connection with the diseases caused in plants by parasitic fungi.

A monument to the great anatomist Malpighi was unveiled on September 8, in his native town of Crevalcore.

The last number of the *Proceedings* of the Zoological Society includes two papers which form important additions to the knowledge of the land fauna of Spitsbergen. The collections described were formed during Sir Martin Conway's expedition by Dr. J. W. Gregory. The first paper is by Mr. D. J. Scourfield, and describes the Rhizopoda, Tardigrada and Entomostraca The Rhizopoda include twenty-one species, all of which have a wide distribution in space, but are all new to the Spitsbergen fauna. In several species, especially *Euglypha ciliata* and *Nebela collaris*, the shells are abnormal in shape, which Mr. Scourfield suggests may be due to the severity of the climate under which they live, for the specimens of *Cyclops* collected are also abnormal. Among the Tardigrada four species are described, of which one, *Echiniscus spitsbergensis*, is new. Only one Water-bear has been previously recorded from Spitsbergen; it was described by Goes in 1862 as an ally of *Macrobiotus dujardini*. Two species of Acarina are recorded, both additions to the Spitsbergen fauna, as are also the two species of Copepoda.

A second paper, by Mr. David Bryce, deals with the Rotifera Previously the only records of members of this group from Spitsbergen were the mention of two indeterminable species by Goes in 1862, and the identification of one species (*Callidina alpium*) by Ehrenberg in 1869. Mr. Bryce's paper adds twenty-five more species belonging to ten genera. Two of the species (*Stephanops tenellus* and *Callidina venusta*) are new. The commonest species collected was *Callidina plicata*. The previously known species are North European in range: some of them are very rare; one *Callidina cornigera* has been previously known only by two single specimens. Bergendal has recorded eighty-two species of Rotifera from Greenland, but from a latitude about 700 miles further south than the Spitsbergen specimens were collected; and of the Greenland species only three were collected in Spitsbergen.

The number of investigations in physiology and the allied sciences now made in the United States of America having become so numerous, it has been thought that the present means of publication need supplementing; hence it has been decided to start in January next a special journal, entitled *The American Journal of Physiology*, to meet the needs of investigators in physiology, physiological chemistry, physiological pharmacology, and certain other branches of biology. Each volume, which will be edited for the American Physiological Society by an influential board of seven doctors, will contain about five hundred pages, divided into parts or numbers, to be issued whenever enough material has been received. The promoters are not very sanguine as to the financial success of their enterprise—at any rate, for some time to come; and they, therefore, solicit the aid of all friends of learning until the journal shall be established on a self-supporting basis. The yearly subscription price for the British Isles is a guinea, and subscriptions should be sent to Dr. W. T. Porter, 688 Boylston Street, Boston, Mass., U.S.A.

We offer our congratulations to our contemporary the *Electrical Review*, which, with its current issue, completes the twenty-fifth year of its existence. This event is celebrated in a fitting manner by the publication of a number of articles by specialists dealing with the progress made in the various departments of physical science during the time the *Electrical Review* has been in circulation. Our space is too limited to enumerate even the titles of the special contributions to this number; it must suffice for us to say that a vast amount of information is given in a very condensed form, the perusal of which is certain to interest all physicists.

Dr. Donald MacAlister, of Cambridge, has, with the assistance of Prof. Cattell, of the University of Pennsylvania, just completed a thorough revision of the second part (Sections ix.-xv.) of his English translation of Ziegler's "Text-book of Special Pathological Anatomy." This announcement will be welcome to many students of the subject, as the book has been inaccessible for some time past. The new part will be published in the course of a few weeks by Messrs. Macmillan and Co., Ltd.

We have received from Messrs. George Newnes, Ltd., the first part of the serial issue of Nansen's "Farthest North," which is being brought out in this popular form by arrangement with the original publishers of the work. The book will be completed in twenty fortnightly parts.—From the same publishers also comes the November number of the *Strand Magazine*, which, as usual, contains one or two articles treating of science in a popular manner. In the number before us Mr. Grant Allen writes pleasantly on "Marriage among the Clovers," and certain "Pests" are written about by Mr. Warren Cooper. Two of the pests in question, viz. "The Jack Rabbits of the United States," and "The Water Hyacinth of the St. John's River, Florida," have already received notice in the columns of Nature (vol. liii. p. 586, and vol. lvi. p. 332).

The additions to the Zoological Society's Gardens during the past week include a Whooper Swan (*Cygnus musicus*), a Night Heron (*Nycticorax griseus*), European, presented by Mr. W. H. St. Quintin; a Californian Quail (*Callipepla californica*) from California, presented by Mr. Walter Robertson; a Gannet (*Sula bassana*), British, presented by the Rev. G. H. Thompson; a Dwarf Chameleon (*Chamæleon pumilus*) from South Africa, presented by Mrs. Wolterbuk; a Common Seal (*Phoca vitulina*), British, deposited; a Rosy-billed Duck (*Metopiana peposaca*), three Anomalous Snakes (*Rhadinæa anomala*) from South America,, two Golden Plovers (*Charadrius pluvialis*), two Dunlins (*Tringa alpina*), four Common Gulls (*Larus canus*), British, purchased; three Himalayan Monauls (*Lophophorus impeyanus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE NOVEMBER METEORS (LEONIDS).—Although it was known that the presence of the moon would hinder materially the brilliancy of the display of the members of this particular meteor swarm, many hoped that the weather at least would compensate us for that of last year. We were, however, doomed to disappointment, and clouds were the order of the night, both in London and in many other counties where observers were on the watch. Mr. Denning, writing from Bristol on the 15th, observes lamentably, ". . . up to the present time my results are negative. November 12 was cloudy all night, November 13 cloudy, except for an interval of partly clear sky between 11h. 30m. and 14h., and November 14 overcast all night."

Saturday night (November 13) in London proved really a first-class night for such observations, excepting, of course, the presence of the moon. It is true that white fleecy clouds occasionally came rolling up from the southward, but they afforded a magnificent spectacle, and soon disappeared in the north, leaving the sky brilliantly clear. Three facts were impressed on one when watching the heavens: first, the dearth of meteors; second, the great number of stars visible considering the brightness of the moon; and third, the extreme mildness and absence of dew.

In a watch lasting more or less continuously from 9h. to 17h. o'clock, only twenty meteors were seen, fourteen of these being estimated as Leonids, three Andromedes, and two Lyrids.

The five most brilliant Leonids were plotted directly on a star chart (Mean Equinox 1870). Three of these, when their trails were prolonged backwards, converged nearly to a point giving the coordinates of the radiant point as 152°, + 25°, while the other two apparently emanated from 171°, + 19°. The details of each are as follows:—

No.	G.M. Time	Coords. of commencement		Coords. of end		Colour	Remarks
	h. m.	°	°	°	°		
1...	13 50 ...	177	+ 4 ...	187	− 18 ...	Yellowish	Very quick
2...	14 10 ...	184	+26 ...	197	+33-4 ...	—	,,
3...	14 50 ...	143-4	+22 ...	123-4	+ 13 ...	Yellow-blue	,,
4...	15 30 ...	156	+35 ...	161	+ 45 ...	—	,,
5...	15 55 ...	166	+11 ...	182	− 8-9 ...	Reddish tinge	Very slow, nucleus, very wavy trail near head just before disappearance

Number 5 was somewhat unusual, falling towards the south-eastern horizon very slowly, that part of the trail close to the head being distinctly wavy. It may be mentioned that two cameras pointed first towards the Pleiades in the earlier portion of the evening, and towards Leo when sufficiently high in the sky, recorded not a single trail, although fourteen plates were exposed for forty minutes each during the time of observation.

JUPITER'S THIRD AND FOURTH SATELLITES.—Prof. Barnard has communicated to the *Astr. Nach.* (No. 3453) some most interesting observations of the third and fourth satellites of Jupiter, together with a set of drawings of these bodies made both out of and at the time of transit. These observations are valuable, as they can be compared with those made by Mr. Douglass. and described in the *Astr. Nach.* (No. 3432). That they differ from these latter is only natural considering the difficulty of the observations themselves, but that this difference is so great and fundamental is very surprising. Mr. Douglass, it will be remembered, found that the surfaces of these two satellites were covered with series of fine dark lines, measuring less than 0″·1, or about 200 miles, and similar somewhat to those surface markings as observed at his observatory upon Mars, Venus, and Mercury. Prof. Barnard, on the other hand, has failed altogether to see these details, although he has employed the 36-inch Lick refractor in the attempt; the markings he observed always appeared to be large and more or less diffused, with the exception of the white polar caps which, as he says, are exactly like those of Mars. In the case of the third satellite the cap is generally situated at the north limb, although on one or two occasions a white southern cap has been observed. Both caps of the fourth satellite have been clearly distinguished, that at the north being sometimes exceptionally large, covering a surface equal to one-quarter to one-third of the diameter of the satellite.

Most interesting are the appearances and apparent changes of form which these satellites undergo when in transit. Thus, as regards the third satellite the transit "was very remarkable. The satellite appeared as a black or very dark spot on its disc, and close to the south limb of the satellite was a small, round, very white spot, fully as conspicuous as I have shown it. No other details were seen on it." The drawing referred to above shows the satellite's disc very nearly black, the spot measuring about one-sixth of the diameter of the satellite being represented nearly white. The observations of Prof. Barnard show fairly conclusively that the changes in form of the discs as they pass across the primary are only apparent, and not due to any peculiarity of shape of the satellites themselves. In fact, he himself is perfectly convinced that they are caused by the relative intensities of the satellite's markings in their transit over those of the primary. The peculiar feature of a double dark spot, or an elongated white spot shown by the first satellite in transit, is due to the fact that this body has a bright equatorial region and dark poles. When transiting across a bright portion of Jupiter's disc, the satellite appears like a double dark spot, and when over a dark portion like an elongated white one.

The discrepancy between the forms of the surface markings on these satellites, as seen by two such observers as Mr. Douglass and Prof. Barnard, is indeed remarkable, and it would be of interest to know what would be the result of an interchange of instruments at the time of the next oppositions.

COMET PERRINE (OCTOBER 16).—The following is a continuation of the ephemeris of Comet Perrine for the ensuing week as computed by Herr. J. Möller (*Astr. Nachr.*, No. 3456):—

12*h*. *Berlin M.T.*

1897.	R.A.	Decl.	log *r*.	log Δ.	Br.
	h. m. s.	° ′			
Nov. 18 ...	18 28 14 ...	+64 43·0 ...	0·1436 ...	9·9896 ...	0·9
19 ...	26 1 ...	63 53·0			
20 ...	24 3 ...	63 4·6 ...	0·1418 ...	9·9993 ...	0·8
21 ...	22 18 ...	62 17·7			
22 ..	20 43 ...	61 32·3 ...	0·1403 ...	0·0089 ...	0·8
23 ...	19 17 ...	60 48·3			
24 ...	17 59 ...	60 5·7 ...	0·1388 ...	0·0184 ...	0·8
25 ...	16 49 ...	59 24·6			
26 ...	18 15 45 ...	+58 44·8 ...	0·1376 ...	0·0278 ...	0·7

THE VARIABLE STAR β LYRÆ.—If Argelander's formula be used for the determination of the times of minima and maxima of this variable star, it will be found that these times do not exactly correspond with those now observed. Herr Pannekoek has recently undertaken to investigate the cause of this discrepancy, and has published his results in the *Koninklyke Akademie van Wetenschappen te Amsterdam* (vol. v. No. 7). A brief account of the main results are, however, contributed to the *Astronomische Nachrichten* (No. 3546). The improved formula for determining the times of the principal minima is given by Herr Pannekoek as

$$1855 \text{ Jan. } 6, 604 \text{ Greenwich M.T.} + 12{\cdot}908009\,E + 0{\cdot}000003855\,E^2 - 0{\cdot}000000000047\,E^3,$$

and he adds a table, which facilitates greatly this computation, containing every twentieth minimum from E = − 500 (1837) to E = + 1500 (1908).

To determine the amount, if any, of a variation in the light curve, Herr Pannekoek divided the period of observation into two parts, before and after 1870, and obtained two sets of mean values for the mantissæ of the principal points reckoned from a principal minimum:

	1st max.	2nd min.	2nd max.
	d.	d.	d.
1842–1870 ...	3·12 ...	6·40 ...	9·54
1870–1895 ...	3·32 ...	6·48 ...	9·73

This showed that the difference between the intervals from the principal minimum in the case of the maxima was quite apparent, while in the case of the secondary minimum it was comparatively small. It is pointed out, however, that a possible cause may be due to different methods of curve-drawing, some observers drawing the curves symmetrically, and others not. The curves, he finds, further show small irregularities in intensity somewhat of the same kind as those observed in η Aquilæ, which render uncertain the times of first maximum and principal minimum. Herr Pannekoek finds that only the variation in the time of the maxima can be put down to causes other than those of errors of observation and drawing.

GEOLOGISTS IN CANADA.

IN recording in our columns the proceedings of the British Association at Toronto last August, passing reference was made to the excursion to the Pacific coast which was to take place at the close of the meeting. This excursion was in every way such an unqualified success, and especially from the point of view of the geologist, that we think some further account will be acceptable to British geologists who were unable to attend the meeting.

It was indeed a tour which could not but make a lasting impression upon all of us who took part in it. The vast extent and diversity of the country traversed; the richness of the material resources of the Dominion of Canada; the energy and enterprise of its inhabitants; the orderly conditions of the new civilisation even in the remotest settlements, were features which could only be properly appreciated after an experience of this kind. And beyond these general impressions it was scarcely possible for the student of any branch of science to traverse the great continent without accumulating fresh material and fresh ideas in his own particular subject. Amid a panorama of scenery always interesting and sometimes magnificent, we were carried from ocean to ocean in the greatest comfort, in many parts of the course through stretches of mountain and forest which but for the railway would have been absolutely impenetrable for the traveller however well equipped.

The arrangements for the excursion were made by the Local Committee in Toronto, who invited a limited number of the visiting members of the British Association to take part in it. To these members the Canadian Pacific Railway Company munificently presented tickets for the whole length of their main line, with the privilege also to travel without cost over any of their branch lines. A special car was attached to each of the west-bound trains leaving Toronto on three consecutive days, and remained at the service of the members until they reached the Pacific coast. The excursion party thus resolved itself into three groups, which were so arranged by the Local Committee that those of like interests should as far as possible travel together.

The geologists and their friends the geographers formed the third of these groups, leaving Toronto in the sleeping car "Chaudière" on the noon of Friday, August 27. They were especially fortunate in having for their leaders Dr. G. M. Dawson, the Director of the Canadian Survey, and Prof. A. P. Coleman, of the Toronto University and the Bureau of Mines of Ontario, men whose knowledge of the country to be traversed was so intimate that no point of interest could escape unnoticed. Among the members of our party were Dr. W. T. Blanford, Prof. W. C. Roberts-Austen, Dr. C. Le Neve Foster, Prof. Albrecht Penck (of Vienna), Prof. W. M. Davis (of Harvard), Prof. K. Huerthle (of Breslau), Sir George Robertson, Prince Kropotkin, Prof. H. E. Armstrong, Colonel F. Bailey, Prof. T. Hudson Beare, Dr. H. O. Forbes, Mr. W. E. Hoyle, Dr. A. Harden, Dr. J. Scott Keltie, Mr. G. W. Lamplugh, Dr. H. R. Mill, and Prof. H. A. Miers.

From the very outset the geological interest of the journey was continuous. Scarcely had we left Toronto when Prof. Coleman pointed out to us the long stretches of the Iroquois beach, an ancient tilted shore-line of Lake Ontario. Next we passed for three or four hours over an irregular plain of drift, beneath which lay hidden the almost undisturbed Palæozoic rocks of this region. After skirting the shores of Lake Simcoe, we crossed the great unconformity, and found ourselves upon that vast Archæan protaxis which was thenceforward to be traversed for a distance of over 1100 miles almost without interruption. Night closed on the characteristic scenery of this Archæan country—a timbered wilderness with hummocky rocks, everywhere smoothed and polished by glaciation, rising into low hills and enclosing lakes and lakelets innumerable with swamps or sluggish drainage channels between. Lake Nipissing, with its ancient terraces, through which it is believed that the outflow of the Upper Great Lakes once found its way into the Ottawa River, was passed in the night. In the morning we found ourselves "side-tracked" at Sudbury, in the centre of a mining region, which already produces fully one-half of the world's consumption of nickel, and could supply more.

With that energetic hospitality which met us at every halt, the Mayor of Sudbury, with a local committee of reception, was early astir with a carefully arranged plan for the day. After a public breakfast a special engine was at hand to take the "Chaudière" and its occupants to the renowned Copper Cliff Mines. Through the admirable forethought of Dr. Dawson, who struck something akin to awe into us by his power of conjuring up in the most unlikely places whoever or whatever we might most desire, Mr. A. E. Barlow, of the Canadian Survey, had made his appearance on the train during the night from his camp in the woods, and was ready to give us the benefit of his intimate knowledge of the district. With him and Prof. Coleman as our guides, we studied to the best advantage, at the outcrop, the mode of occurrence of these great deposits of nickeliferous pyrrhotite and chalcopyrite which apparently are segregated in an area of gabbro near its contact with granite. We were then shown through the surface works of the mine, the managers pointing out to us each stage in the reduction of the ore, from its initial crushing and roasting to its smelting into "matte," in which form it is sent east for further refinement. Some of these processes were especially interesting to the metallurgists and chemists of our party.

On leaving this mine we divided into two companies, those who were anxious to see more of the nickel-mines visiting Denison, about twenty miles west of Sudbury, where the prospectors were developing an ore-deposit similar in character to that of Sudbury, but remarkable as containing also some platinum in the form of the rare arsenide, sperrylite, and a little gold. Here some of the earth overlying the ore-deposit was panned out, and a fair show of grains of sperrylite obtained.

The other members were conveyed by their special engine to Fairbank, a few miles distant, whence they went in wagons over a terribly rough "corduroy" road to a place in the woods where a curious vein of carbonaceous material had been struck, which its discoverers hoped might prove a valuable source of fuel. This material, known as anthraxolite, though not a true coal in the ordinary sense, is composed of almost pure carbon. It occurs in this place as an irregular upright vein, in some parts several feet in width, somewhat interpenetrated by quartz. This vein cuts across the bedding of the surrounding dark carbonaceous slaty rocks, which are either of Lower Cambrian or of Huronian age.

At this place, as we wound our way along the forest trail towards the luncheon place, there was a sudden and for the moment inexplicable stampede of the foremost members of the file, who had unwittingly plunged into a hornet's nest, and suffered inconvenience in consequence. And this little accident was the only mishap of the whole journey!

After luncheon a further expedition was made in birch-bark canoes up the Vermilion River, for three or four miles, to a spot on Vermilion Lake where a shaft had been sunk to develop another vein of the anthraxolite, but where its mode of occurrence was not so clearly seen. On regaining our vehicles, we were conscious on starting of a sense of loss, and then perceived that our two most prominent foreign members were missing. We discovered them, however, placidly eating pie in the log-cabin of a settler. They eagerly explained that they were "studying the customs of the country"—a phrase which thenceforward acquired a special significance.

In returning to Sudbury our train was stopped to allow Mr. Barlow to point out an intrusive contact of the Laurentian granite upon the brecciated edge of the diorite (Huronian ?), which appears to be the normal relation of the two rocks in this region. This makes it somewhat difficult to understand how the metalliferous ore has been concentrated at the original margin of the basic mass.

In the evening we were banqueted by the citizens, and after many mutually complimentary speeches retired to the "Chaudière" with the consciousness of a well-spent day.

The morning of the 29th found us traversing a sparsely inhabited region of lakes and forests to the north-east of Lake Superior. The rocks were for the greater part of Laurentian type, a matted complex of igneous intrusions mostly of granitic character, but presenting now and again a more basic "Huronian" aspect. The marks of glaciation were everywhere visible, on a scale quite inconceivable to the British glacialist—in fact, one might say that this whole day's journey was across a huge glaciated surface.

And here it may be remarked, as illustrating the immense scale of the glacial phenomena of North America, that throughout the whole of our journey of 3000 miles we were never at any one point outside the limits of the glacial deposits, and that in one shape or another the evidences of former glaciation were always visible from our car windows. Moreover, we might have gone eastward from Montreal for an additional 750 miles,

to the shores of the open Atlantic, with still the same glacial surroundings!

In the early afternoon at Heron Bay, Lake Superior lay below us, and until nightfall our course ran through the bold and picturesque scenery of its cliffy margin. Old beach-terraces lying high above the present lake were pointed out to us in many places, these being the margins of different stages of the ancient glacier-dammed lake of vast extent to which the names Warren, Nipissing, &c., have been applied.

Towards evening there came a change in the profile of the land, striking alike to the geologists and the geographers, the familiar low hummocky outlines of the Archæan giving place to the bolder features of broad tabular rock-masses rising high above the lake with cliff-like sides, the bright red tints of which were strongly accentuated by the setting sun. These masses are composed of Lower Cambrian rocks (Animikie and Keweenawan), chiefly red sandstones and shales with some thin limestones, preserved under a capping of columnar diabase, which rest with the most pronounced unconformability, cake-like, upon the irregular Archæan floor, like the Torridon Sandstone on the gneiss in the North-west Highlands.

As if the elements themselves were imbued with the spirit of Canadian hospitality, not only was the weather almost throughout our tour everything one could desire, but also on this particular evening there came a fine display of aurora borealis to charm us when darkness had hidden the land.

The following day, August 30, we arrived early at Rat Portage, the chief mining centre of Western Ontario, where we found Mr. McInnes, of the Canadian Survey, just in from his camp to meet us. Here again we were received by the principal citizens, and led at once to the wharf on the beautiful Lake of the Woods, where a special steamboat had been chartered for us. The extremely interesting Archæan geology of this region has been made known to European geologists by the classic Canadian Survey Memoir of Prof. A. C. Lawson, and we rejoiced in the opportunity to examine some of the sections described by him. Our first object was to visit the highly successful Sultana gold mine on an eastern arm of the lake. On the way thither we stopped to land at one of the Indian Reservations, where a curious native burial-ground had attracted our attention; and the pathetic mementos which decorated a child's grave excited our somewhat too obtrusive interest. Later in the day we were enabled to visit a second camp, and see something of its living inhabitants.

At the Sultana Mine, where a mill of ten stamps is already at work and a number of additional stamps are being erected, we were shown the process of treating the ore, which is largely free-milling, only 20 per cent. of the gold being left in the concentrates for recovery by the chlorination process. The metal occurs in a quartz vein, at one place admirably exposed at the surface, which traverses the country-rock near the contact of granite, said to be Laurentian, with Huronian diabase. Throughout the Dominion it appears to be in similar positions around the contact of intrusive masses that the chief metalliferous deposits are found.

Led by Prof. Coleman, to whom this whole region is familiar, and by Mr. McInnes, we next ascended the hill to the east of the mine, and further examined the junction of the so-called Laurentian granite with the Huronian rocks, and noted the intrusive character of the former. Then rejoining our steamer we went westward to some islands in the lake, on which the agglomeratic and apparently volcanic character of the Huronian rocks was well displayed.

The waters of the lake were thick with a minute green floating organism, probably an alga. It is said that there are 13,000 islands in this lake alone; which may be an over-estimate, but they are certainly very numerous. We were told that they were to be bought at all prices, from five dollars upwards, so that the possession of a private island in this part of the world need not be an expensive luxury. And it might, perchance, hold a gold-mine!

Spending the night at Rat Portage the geologists were early astir next morning, and found time for further investigation of this interesting locality. Under Prof. Coleman's guidance we studied the contact of Laurentian and Huronian at several points to the westward of the town, near where the waters of the lake pour through three distinct outlets to form the Winnipeg River. It can scarcely be said that our investigations enabled us to grasp the complex relationship of these great rock-groups, though in some of the sections the gneissic Laurentian seemed clearly to be intrusive upon the Huronian. But the general impression to be gathered from all we saw of these rocks was that the term Huronian might include very different rocks in different places, and that still more was this the case with the term Laurentian. Until the Post-Archæan rocks are reached no strict divisional lines seem possible. Upon such difficult problems as these of the oldest rocks, however, the casual observer of a few isolated sections has really no right to own an opinion.

The enormous water-power which the Lake of the Woods contains, has to a slight extent already been utilised at one or the other outlet, in the production of an electric supply for the city, and for driving extensive flour-mills at Keewatin. But a fine dam is now nearly finished by which the whole outflow will be made available for industrial purposes, and it has even been proposed to convey the power to Winnipeg over 100 miles distant. The navigation of the lake between Rat Portage and Keewatin had lately been much impeded by a floating island of vegetation, but this, as we saw, had been surrounded with a boom of logs, and fixed to the shore.

Boarding the train again at Keewatin, our course lay for a few hours longer through typical Archæan country; but gradually the old rocks sank beneath the drift-plain, and before reaching Winnipeg in the afternoon we had passed once more on to a hidden platform of the Older Palæozoics, and had reached the edge of the great prairies. We were now within the basin of the glacial Lake Agassiz. This extinct lake is believed by its explorer, Mr. Warren Upham, to have extended eastward well beyond the Lake of the Woods, and westward to the "second prairie steppe" of Dr. Dawson, a breadth of about 250 miles, while the length from its termination southward in Minnesota to its northern shore against the ice-sheet north of the present Lake Winnipeg may have been nearly 700 miles; its area has been given as about 110,000 square miles, or greater than the total of the six existing great lakes, Superior, Michigan, Huron, Erie, Ontario and Winnipeg! It is to its finer sediments that the wonderfully productive character of the soil of the Manitoba prairies is largely due.

At Winnipeg, the "half-way house" of the continent, the west-bound trains stop for an hour and a half to refit. With special tram-cars at our service, we were thus able to see something of this substantial city with its many handsome buildings. The old Hudson Bay post, Fort Garry, standing in their midst, reminded us how marvellously rapid has been the growth of this western capital.

On the evening of August 31, with Winnipeg behind us, the crossing of the plains had fairly commenced. Some writer—it must surely be Lawrence Sterne—has pointed out the great value of a plain to the discursive recorder of travels. One could not do better than follow this preceptor by setting down here some general reflections which might otherwise find no place for themselves.

First, we have to regret how few in number were the British geologists to avail themselves of this magnificent opportunity for study. It is often urged against us, and not without reason, that we are too insular in our ideas and too apt to ignore the work done beyond our borders. Certainly the geologist who confines his attention solely to the neat details of British stratigraphy can scarcely hope to realise the true proportions of the problems with which the earth-student must deal. Explanations of phenomena which seem quite applicable on the small scale, often reveal their essential inadequacy under wider conditions of application. And for a corrective study of broad conditions this transcontinental journey must assuredly be unrivalled.

The railway goes more or less at right angles to the strike of the continent, and traverses therefore all the main rock-masses of which the land is built, and all the great structural features by which it is diversified. Hence the final impression which the geologist receives is that of some vast diagrammatic section of a continent. Even the scant time spent in making the traverse was, on this occasion, compensated for by the presence of the men who knew all that is yet known of the route, and who were always ready to impart what they knew.

Next, although in the abstract patriotism is out of place in science, let us record the sense of gratification felt by the British members of the party, that across the breadth of this wide and prosperous Dominion we were among brothers. One could scarcely make a journey of this kind without becoming a little more Imperialist than before.

Then let us set down our admiration for the work of the

Canadian Geological Survey. Considering the means at its command, and the positively inconvenient extent of its territory, it is marvellous how much has already been accomplished, and how clearly the general structure of the country has been brought out. It was pleasant to observe, too, how well its work was appreciated among the people for whom it was primarily intended, and how in the mining districts the geological maps we carried were quite familiar to the prospectors and mining people generally, who were usually themselves furnished with copies.

And now for the Plains! They were a knotty problem for our geo-morphologists, not easily to be solved by "base-levelling" or other familiar methods, and we crossed them without properly understanding them. Considering their elevation, it is clear that they should not remain so flat!

But, taking them as we found them, we passed during the night from the first or Red River Plain to the second steppe, where there are some undulations, and before noon had crossed this also, and had reached that remarkable feature the long ridge-like Missouri Côteau, which is largely made up of glacial detritus, and is probably morainal in origin. We then reached the third steppe, which has an elevation of a little over 2000 feet above sea-level at its eastern edge, but rises gradually to over 4000 feet at the foot of the Rocky Mountains. These plains are all underlain by Laramie and Cretaceous rocks lying flat and undisturbed, containing seams of lignite, and in places yielding natural gas. There were few sections, however, either natural or artificial, excepting in the superficial drift deposits. In these drifts boulders of Laurentian rock are very numerous, many hundreds of miles from their source. The third steppe is almost entirely a cattle-ranching country, with a dry climate, as is indicated by the numerous salt lakes visible from the railway. In crossing it, the Cypress Hills, an outlier of Miocene rocks, broke the horizon to the southward, and the surface generally became more diversified than in the lower steppes.

At Medicine Hat, in the evening, we crossed the South Saskatchewan, and under ordinary circumstances should have entered the Rocky Mountains during the night. But our director determined that we must make the approach by daylight, and gave orders that our car should be detached in the night at Calgary, where at daybreak the long range of mountain peaks was just in view. A special engine had been conjured from somewhere, and stood ready to take us forward to Banff. By this arrangement, what was for the geologist the most impressive part of the route was seen to full advantage.

[*From a photograph by Prof. H. E. Armstrong.*

FIG. 1.—The western or dip-slope of Mount Rundle (9635 feet); a faulted and tilted mountain-block, chiefly of Devono-Carboniferous Limestones. From Banff Hot Springs.

As we approached the mountains we saw how the Laramie and Cretaceous rocks gradually lost their horizontality, becoming more and more tilted and crumpled as the foot-hills were traversed, until—at the entrance to the mountains—the disturbances suddenly culminated in a magnificent overthrust, as clearly visible on the bare mountain-wall as in a text-book diagram. By this thrust the Cambrian, Devonian, and Devono-Carboniferous limestones have been driven eastward over the broken Cretaceous strata for a horizontal distance estimated by Mr R. G. McConnell at seven miles, with a vertical displacement of 15,000 feet.

We stopped just long enough at Kananaskis to gain a clear impression of this grand section, and were then taken forward into the mountains.

From this point onward the line afforded a constant succession of studies for the geologist which could not fail to arouse his enthusiasm. The boldly-bedded character of the strata, with the planes often picked out by new snow, the steepness of the slopes, and the absence of vegetation, combined to bring out with the utmost distinctness details of structure which ordinarily can be discovered only after infinite labour and research. Infold and overfold, syncline and anticline, thrust-plane and fault were alike visible. Under such conditions the study of mountain-structure acquired a fresh significance, and even those of us who before had paid no attention to the subject now pursued it with zest.

The general character of this region is summed up as follows in the admirable report of Mr. McConnell[1]:—"This portion of the Rocky Mountains . . . is characterised in its eastern part by a series of great fractures and thrust faults, in the centre by broad sweeping folds, and in the west by folding and crumpling, accompanied by the development of cleavage-planes and a limited amount of metamorphism. Among its other more important features may also be noted the absence of recognisable unconformities, the absence of any of the older crystalline schists, the relatively smaller amount of disturbance in the central parts of the range than towards the edges, the want of similarity in the sequence of the formations east and west of the axis, and the marked preponderance of calcareous beds between the Middle Cambrian and the Cretaceous."

Our course lay up the Bow Valley, which is here carved out of a trough of Cretaceous rocks, wedged in among and apparently overlain by Cambrian strata. In this trough coal is mined, and although on the Plains the coal of Cretaceous age is lignite of poor character, the quality improves as the mountains are approached, until in this district both bituminous coal and anthracite are obtained.

Not only in geological interest but also in the beauty of its mountain scenery the Canadian Pacific is undoubtedly far superior to any other line crossing the North American continent. We were here within the limits of Canada's Rocky Mountain National Park, and the views we now obtained delighted us. Arriving at the well-known tourist centre, Banff, about noon, and establishing ourselves at the large new C.P.R. Hotel, where we found Prof. John Macoun of the Canadian Survey awaiting us, we set about to make the best of our time. A ridge, known as Sulphur Mountain, rising 3000 or 4000 feet above the valley to the west of the hotel, proved attractive to the more energetic of our party, and although Prof. Macoun had already made the ascent earlier in the day, he expressed his readiness to start again, and undertook the leadership of the group. For the others, who were content to view the many points of interest in the beautiful valley, carriages were provided.

From the grand outlook on the crest of Sulphur Mountain the chief features of the region were readily grasped. The Bow River far below us broke across the range, while on either hand were deep longitudinal valleys running between tilted orographic blocks of Palæozoic limestones, out of which a succes-

[1] Canadian Survey Reports for 1886, vol. ii. Report D, p. 40.

sion of mountainous ridges had been carved, all with precipitous faces to the east, and long dip-slopes to the west. Near the summit, about 8000 feet above sea-level, there were distinct traces of glaciation, apparently transverse to the ridge.

A hurried descent put us into fit state to appreciate the luxury of a bath from one of the hot sulphur springs, already celebrated for their restorative properties, which well up along a line of fault at the foot of the mountains. Then after a reunion at the hotel we retired once more to the "Chaudière," which had begun to assume quite a home-like aspect.

Early on the following morning, September 3, the west-bound train took us again in tow, our course for some time following up the Bow River amid scenery of increasing splendour, with glaciers showing here and there in the mountains ahead. Then, turning westward up a small tributary, the train entered the Kicking Horse Pass; and soon a painted signboard announced the Continental Divide; and we breakfasted at Field Station on the Pacific slope, with the shapely Mount Stephen just above us. From this point onward the geological structure became more complex, the foldings more acute, and the outline of the mountain peaks less and less dependent upon the bedding, and in running down the beautiful valley of the Wapta or Kicking Horse to the Upper Columbia depression we passed into the region of complication and alteration which forms the core of the mountain ranges. Thenceforward to the Pacific coast the task of the travelling geologist is difficult, and but for the work which has already been published on the Selkirks and Coast Ranges, and the presence among us of the man who had done it, we should have been at a loss to understand what we saw.

The Columbia River was reached at Golden, and was followed thence northwestward to Beaver Mouth. The great terraces of stratified material which line its valley up to high levels attracted attention both here and at Revelstoke, where the railway again crosses the river below its great north bend. Leaving the Columbia, our track turned south-westward, up Beaver Creek and Bear Creek, to make its difficult traverse of Selkirk Range. The Palæozoic rocks had now undergone a great change of character, and instead of the flaggy limestones of the Eastern Rockies, we found ourselves among unfossiliferous argillite schists and quartzites, everywhere highly disturbed and sheared. The denser timber and the many long snow-sheds lent additional obscurity to our geological impressions.

Around Rogers' Pass, 4300 feet above sea-level, lies the finest mountain scenery of the whole route, but on this day the highest tops were hidden in clouds. A short run from the summit brought us, at 2 p.m. or 14 o'clock railway time, to our next halting-place, the C.P.R. Hotel at Glacier.

At this place our first objective was, of course, the grand Illicilliwaet Glacier, the snout of which lies two miles back in the forest. Around the glacier a busy afternoon was spent—one of our party, expert in such work, fixing points for measuring its future recession; others scaling the lateral moraines of blocks of sheared quartzite in which blue quartz grains were conspicuous; others attacking the glacier itself, and studying the fine display of structures which the body of the ice reveals. But the time was, of course, too short for more than a mere skirmish around its lowermost portion, and the great icefields above remained unseen.

It had been proposed on the following morning to climb one of the ridges overlooking these icefields; but here for the first and only time the weather failed us, and though after breakfast Prof. Coleman, who made light of all obstacles, led the way towards the Asulkan, another of the many glaciers of this region, he found but few followers to face the discomfort of the saturated forest.

Some curious feats in engineering have been performed in carrying the railway down the western slope of the Selkirks, but none are more remarkable than the great "loops" by which the descent is made from Glacier into the cañon of the Illicilliwaet. After leaving this place we had all around us the heavy timber of the Pacific region, making, where unburnt, a fine foreground to the peaks and glaciers behind. But the wholesale devastation which has been wrought by forest fires throughout this region is distressing to any eyes but those of the Western man who has come to regard timber as the chief hindrance to the rapid development of his country.

At Albert Cañon the train stopped long enough to allow our photographers to spoil their plates in attempting views of a sombre river-gorge. At this point the dark schists with a band of crystalline limestone (part of the "Nisconlith Series" of Dawson) are believed to lie very near the base of the sedimentary rocks of the Selkirks. At any rate, a short distance further west we entered upon the region of gneiss, mica-schist and granite, which the Canadian geologists recognise as a portion of the Archæan nucleus or axis Out of such rocks the western part of the Selkirks and much of the Gold Range have been carved. We found opportunities to examine them, during the return journey, at a few points around Revelstoke and Arrowhead, and from their intricate structures one might judge that several different stages of movement and several distinct periods of eruption were represented. Unlike the conditions in Eastern Canada, in British Columbia westward of the Selkirks the Palæozoic and even Mesozoic rocks are so involved and altered among eruptive and intrusive masses, and so implicated with each other by the earth-forces which have built up the mountain-ranges, that the evidence for age is rarely at hand, and one would need to be thoroughly well acquainted with the country to pronounce upon any part of it. But one could see that these schists and gneisses form the Central Complex of the ranges; and they seem of high antiquity. In travelling from east to west across the mountains we had seen the effects of crustal forces of gradually increasing intensity, acting usually from west to east. We were now upon the focus of these forces, where their intensity had obscured the evidence.

[*From a photograph by Prof. H. E. Armstrong.*

FIG. 2.—The eastern face of Mount Rundle, Banff.

At Revelstoke, the same evening, the Columbia was crossed for the second time, the great river flowing south-easterly here, instead of north-westerly as where we had crossed it on the previous day, on nearly the same latitude, but about 150 miles nearer its source. The valley systems of this part of the continent are peculiarly interesting for the physiographer, and present some curious problems which are yet unsolved. In this instance the Columbia and its great tributary, the Kootenay, have their sources close together in the same great valley: the one flows north, and then swings round sharply southward; the other

flows south, and swings northward to their union, the Selkirks and associated mountain ranges being thus completely encircled. Among our party were those who have struggled bravely with such problems, and to their investigations we shall look for further enlightenment.

From Revelstoke the C.P.R. Company has a line of communication by rail and steamboat into the celebrated West Kootenay mining district, by way of that beautiful expansion of the Columbia River known as the Arrow Lakes. Through the liberality of the British Columbian Government, side-excursions were organised into this region, and on our return from Vancouver the majority of our party took advantage of the opportunity to visit the brand-new mining town of Rossland, around which are grouped the chief mines of the district. Here, as everywhere else in the province, every facility was afforded us to see all that was best worth seeing. We visited such well-known mines as the Le Roi, War Eagle, Centre Star, &c., where large deposits of auriferous chalcopyrite and pyrrhotite occur, chiefly in veins near the margin of a mass of gabbro intrusive into Palæozoic rocks. The large smelter at Trail, on the Columbia Railway, a few miles distant, was also visited; and those of us who could spare the time went afterwards into the Slocan country, where the richest mines of silver-lead occur. Space forbids a detailed account of these and other branch excursions in the Province; but if it was intended that we should come away impressed with the mineral wealth of the region, that end was assuredly attained.

It was but a twenty hours' journey from Revelstoke to the coast at Vancouver. After rising out of the Columbia depression the railway finds an easy passage through the Gold Range by the Eagle Pass, apparently a valley of erosion now abandoned; though the suggestion had been made that it was providentially supplied to compensate the engineers for their difficulties in the Selkirks and the Rockies.

A chain of small lakes fills the summit of this Pass, to the westward of which lie many fine moraines. In Eagle River, on its western slope, we were fortunate in witnessing a good example of a salmon run, shoals of great fish crowding the shallows of the stream in every part, and lying dead on every bar.

Shuswap and Kamloops Lakes, and the dry interior plateau of British Columbia with its Tertiary volcanic rocks, were passed in the night, and at daybreak of September 5 we were running down the picturesque cañon of the Thompson River, near its junction with the Fraser. In the Fraser Valley itself there is in this neighbourhood a sharp infold of Cretaceous strata; but lower down we saw only ancient-looking slates, supposed to be Cambrian, along with masses of igneous rocks, both of acid and basic types. Near North Bend, where we breakfasted, a dredger was at work raising the auriferous gravel from the river bed. Below this the valley narrows, and the Fraser races southward for miles through a magnificent cañon, down which the railway also passes. Then, at Yale, the river bursts out of the mountains and swings round westward into a broader and apparently much older valley, which it follows from Hope to the Pacific. Following the river, our track went now amid the dense forest of gigantic trees with which the valley is filled, cleared spaces being as yet quite scanty. Of the Laramie or newer rocks which underlie the Fraser delta, we saw nothing, as on the low ground there is everywhere drift and alluvium. Reaching Pacific tide-water at the head of Burrard's Inlet about noon, we drew up at Vancouver half an hour later.

Our long delightful railway journey was completed, and with it our transverse section of the continent. Starting within the Appalachian rim, we had seen, to the east of the prairies, the old Archæan floor on which the Palæozoic strata rested almost undisturbed; then the prairies themselves, with their vast expanses of horizontal, unfaulted Mesozoic rocks; then the foothills, with the same rocks thrown into wavelike swells; then the outer mountains, with dislocated and overthrust masses of various ages, driven eastward from the centre of disturbance; then the inner ranges, with crumpled and altered strata whose age was no longer determinable, and with the central core of metamorphic and plutonic rocks; and then again, to the westward, infolded and crumpled sediments with many igneous interruptions.

All this had, of course, been described for us already by the Canadian geologists in their admirable official and other publications. But what literature could hope to convey an adequate impression of such a region to one unacquainted with it?

At Vancouver most of us took boat at once across the Straits of Georgia, a few on whom time pressed crossing to Nanaimo, and the majority going first to Victoria, whence a special excursion was afterwards made to Nanaimo. It was a glorious afternoon for the passage—the mountains around Howe's Sound half hidden under storm-clouds and half revealed, and a foreground of high gloomy shores, with the deep recesses of the fjords within gleaming with mysterious light.

On Vancouver Island the heartiest hospitality again awaited us, but of our doings there is small space left to tell. In Victoria we found many of our friends of the two earlier parties, and we of the "Chaudière" held a banquet to do honour to our leaders Dr. Dawson and Prof. Coleman. On Monday we were taken in carriages to the points of chief interest in the vicinity of the city; on Tuesday there was a special train to take us to Nanaimo, where coal of excellent quality is extensively mined from rocks of Cretaceous age; and on Wednesday a number of those who intended to visit the Kootenay started for the mainland. Safe to say that we all left the city of Victoria with reluctance, as most do who visit it.

And now the unity of our party was lost, and its fortunes need be no further followed. For all of us this had been a memorable journey, and we started homeward with a lively sense of gratitude to the Local Committee at Toronto, to the Provincial Governments of Ontario and British Columbia, to the Canadian Pacific Railway Company, and, above all, to our leaders Dr. G. M. Dawson and Prof. A. P. Coleman, by whose exertions the complete success of the excursion was secured.

PROFESSOR VIRCHOW'S JUBILEE.

FIFTY years ago Prof. Virchow delivered his first lecture as a university teacher, and preparations for celebrating the event of the jubilee at Berlin last week had been made, but unfortunately had to be abandoned in consequence of a sudden attack of illness which befell Prof. Virchow whilst lecturing two days before the anniversary. Naturally some alarm was felt, but the attack was not serious and passed off quickly. However, at Virchow's request, the festive arrangements were countermanded, and the day was only marked officially by a congratulatory deputation from the University. According to the Berlin correspondent of the *British Medical Journal* the deputation consisted of the deans of the four Faculties, and nearly all the medical professors. Prof. Schmoller, the University Rector, spoke first, and in a warm and able address praised Virchow as the benefactor of millions, and as the great instructor whose methods had gradually permeated almost all schools of thought. Then followed Prof. Heubner, the Dean of the Medical Faculty. He spoke of Virchow's strong personality, and described the commanding impression caused by his teachings which had revolutionised medical thought. It was true that what might be called Virchow's greatest lifework was the introduction of "methodology" into medicine, but this alone did not explain his immense influence. He had pre-eminently the genius of research, and had traded with his talent as a faithful steward. At an age when others had not finished their studies he had attacked scientific problems with his bold and strong intellect, had gone on from problem to problem, until after ten years his work was crowned by the completion and publication of his "Cellular Pathology." Since then he had become the *præceptor mundi* in medicine. Prof. Virchow, in reply, modestly disclaimed what he called excessive honours. He said he felt like a plant from which the withered leaves had been removed to give it a better appearance. He could not deny that his work had always been full of zeal, and supported by the endeavours to keep in view universal principles; and it was true, also, that a certain soberness of judgment had helped him over great difficulties. If he had succeeded earlier than others in forming a school, he owed this to his recognition of the fact that it was impossible to do everything oneself, and to his success in creating a sort of phalanx for his ideas, which had been of sufficient force to overcome resistance, and to prepare a broad basis for later developments. And thus, he was happy to say, he now felt himself no longer indispensable as representing his school, since there were a sufficient number of men sharing his views. He hoped that his little attack of the day before would have no further consequences, and that he had yet some time for work before him; still he could not hide from himself that it was now time to make a stop, to a certain extent; and therefore he was

doubly glad that he had lately succeeded in convincing the Government that somewhere in Germany there must be a place where every student could at all times find instruction on questions of pathology and medicine, that he had been instrumental in securing the rebuilding of the pathological museum.

THE TEMPERATURES OF REPTILES, MONOTREMES AND MARSUPIALS.[1]

THERE has for many years past been a tendency to diminish or ignore the distinction between the cold-blooded and the warm-blooded types of animal life. Yet the difference is one that is not only real, but in some respects radical. In very few, however, of nature's classes is there found a line of sharp demarcation, and the chief purpose of this paper is to point out that, though the distinction between the two types is real, there lies between these two types a line of steady gradation.

Although the invertebrates have the capacity of producing heat, they are themselves cold-blooded. With the exception of the insects, they very rarely rise more than a fraction of a degree above the temperature of the media in which they happen to be. According to observations of Prof. Valentin, polypi, medusæ, echinoderms, molluscs, crustaceans and cephalopods are able to raise themselves about a fifth of a degree, sometimes as much as three-fifths of a degree, above their environment.[2]

Among insects the power of heat-production is very much greater. Though essentially cold-blooded creatures, in the sense that they have no fixed standard of body-heat towards which they approximate, they are almost always warmer than their media; but if they are at rest that excess is only a degree or two. In case, however, of severe exertion, they are capable of warming themselves to a remarkable extent.

In the case of fish, amphibia and reptiles the same is true. At rest all of them remain at the temperature of their environment, rising and falling with it, and showing no capacity, however rudimentary, of maintaining a fixed and characteristic temperature; yet all can warm themselves by exertion. The large blue-tongued lizard, which is common in the southern parts of Victoria (*Cyclodus gigas*), can warm himself as much as half a degree in ten minutes of anger. In five experiments of this sort I found that different individuals had different capacities of being irritated, but the average was a trifle under half a degree for ten minutes of exasperation.

By activity, and consequent heat-production, all fish, amphibia and reptiles seem able to keep themselves a little warmer than the air or water in which they dwell. Dutroche tells us (*Ann. des Sciences Nat.*, xiii. p. 20) that the newt can keep itself from 2° to 5½° above the temperature of its medium, the turtle 1½° to 3½°, and the common green lizard of France (*Lacerta viridis*) from 4° to 7°. Max Fürbinger asserts that species of blind-worm rise as much as 8° above the temperature of the air. Fish at rest appear to take almost absolutely the temperature of the water wherein they live, but after a struggle, or any other form of energy, they may warm themselves two or three degrees.

This, however, has no real affinity with a warm-blooded habit. And yet these creatures approach in a remote way the warm-blooded condition by sometimes developing a capacity for heat-production in the action of their viscera. Dumeril has shown that snakes by mere digestion can warm themselves from 2° to 4°, the maximum temperature occurring about twenty-four hours after a meal.

Thus it constantly happens that these animals, though essentially cold-blooded, may be observed at temperatures somewhat above that of their environment. But in general that excess is not great, and it leaves the distinction between the warm-blooded and the cold-blooded type quite unaffected.

The true criterion of the difference is of course the concomitance of the temperature of the animal and its medium. An animal of the warm-blooded type may vary a trifle in its general body temperature when the climate alters, but it maintains an almost constant degree of heat. The reptile, though it may maintain itself a few degrees above the surrounding temperature, always varies with it, rising and falling so as to keep always the same number of degrees in excess.

To see how far this concomitancy held, I placed two specimens of the large lizard already mentioned into a small tank of water, so that only their noses were above water. I then warmed up the water at various rates of speed by means of one or more lamps. The accompanying diagram (Fig. 1) shows how closely the lizards followed the temperature of the enclosing water.

Cyclodus gigas is a very sluggish creature, and if left alone never warms himself by any exertion, yet if one takes his temperature in the early part of the day it will almost always be found to be below that of the air. After sunset it is generally higher. During two years I kept specimens of this species in a box, sometimes six or eight, sometimes only two or three. I took their temperatures morning and evening, not altogether continuously, but throughout the larger portion of that time. The average of all these observations gave for lizards 18°·1, for the air 18°·4. This is a very close approximation considering that the temperatures had the wide range that lies between 12° and 32°. The lizards appear to be a little colder than the air. This I believe to be due only to the fact that, taking temperatures before eight o'clock in the morning, the lizards were still considerably in the rear of the temperature, while between five and six o'clock in the evening, though they were above the air temperature, the excess then did not wholly balance the morning deficiency.

I am convinced that if one took the temperature of a quiet lizard every hour for a month, the average would correspond

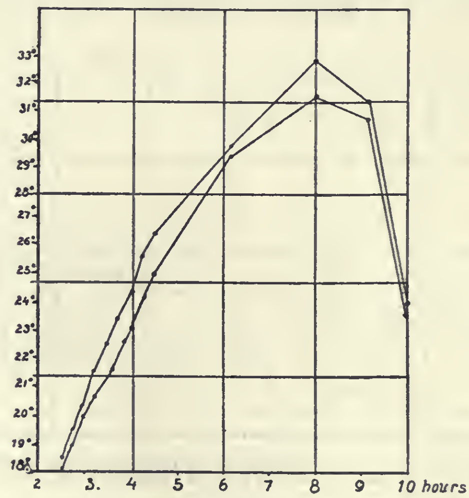


FIG. 1.—To show concomitance of temperatures of lizards and water. Upper line, temperature of water; lower line, temperature of lizards.

almost exactly with the average temperature of the air. The morning and evening observations which I took would give a less exact result, though from them the difference is only three-tenths of a degree.

The steps whereby the more active and intelligent warm-blooded types have arisen from the lethargic level would form a fascinating subject for inquiry, but I purpose here only the much easier and more prosaic one of recording that such steps, however caused, do actually present themselves, and that these are in the most perfect accordance with the existing classification, which is based on anatomical considerations alone.

The monotremes are, in consideration solely of their more reptilian anatomy, placed lowest in the scale of mammals. Their low temperature would entirely justify, were justification in any way needed, the position thus assigned them next to the reptiles. The temperature of the duck-billed platypus has been determined by Baron Miklouho-Maclay to be, as the average of three observations, 24°·8 when the water in which the animals were kept averaged 22°·2 (*Journal* of Linnean Society of N.S.W., viii. p. 425, and ix. 1204.)

Now, the average of forty-five specimens of the ten higher orders of the mammalia, excluding the monotremes and marsupials, is 38°·9, as calculated from Dr. John Davy's lists (*Edin. Phil. Journal*, 1825, p. 300), while the average of a similar but shorter list supplied by Max Fürbinger is 39°. We

[1] By Alexander Sutherland. Abridged from the *Proceedings* of the Royal Society of Victoria, vol. ix. (New Series), 1897.

[2] All degrees in this paper are Centigrade.

may take this as fairly indicative of the general mammal temperature, which does not, except in constitutional disturbances, vary so much as two degrees on either side of this limit. No mammal indeed seems in good health to be warmer than 40°; scarcely any descend lower than 37°.

The platypus, therefore, at only 24°·8 is almost a cold-blooded animal. The only other genus of monotremes, the echidna, carries us a step upwards. Baron Miklouho-Maclay's average of five observations is 28°, while the air was 20°. I have kept at different times fourteen specimens of *Echidna hystrix*, and made twenty-seven observations on the temperatures of all I happened to have at any particular time. I found the average to be 29°·4, or nearly a degree and a half above that of the Baron. But these animals show their affinity with the reptiles by a temperature so variable with the weather that we may readily expect the average of one series of experiments to differ very considerably from that of another.

An echidna one cold morning was as low as 22°; another, brought in from the forest in a sack exposed to a fierce midday heat, registered as high as 36° 6. The accompanying diagram (Fig. 2) represents the general character of the variations, the temperatures in each case being the average of from three to six individuals, which never vary from one another at the same time more than a fifth of a degree.

It will be seen that the temperatures of the echidnæ varied from 22° to 36°·6. This is an immense range for a mammal, and suggests a reptilian want of capacity for temperature regulation. Moreover, though the concomitancy between the air

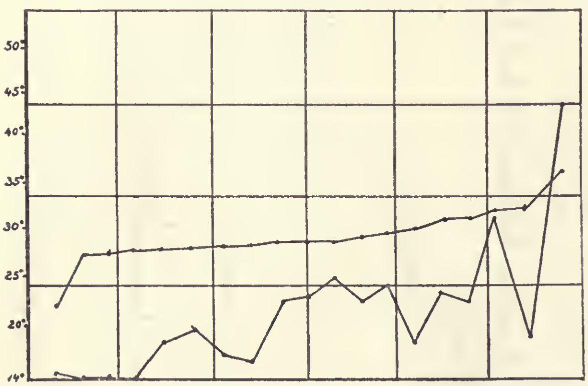


FIG. 2.—To show want of concomitance in the temperatures of Echidna and air. Upper line, Echidna; lower line, air.

and the body temperatures is by no means strict, there is enough to show that the one in a large measure follows the other. It is to be remembered that while a monotreme may rise and fall with the air, yet the one change will follow the other after a definite period of time, and an hour after sunset, though the air in a box may have grown much cooler, the echidnæ in that box may have only begun to cool.

The next stage in the anatomical classification brings us into the order of the marsupials, and here again we make an upward step in view of a temperature higher, but not so high as that of mammals in general; steadier, but not so steady as is usual in all the remaining orders. I have observed the temperatures of sixteen different species of marsupials, and they average 36° exactly, as the result of 126 observations. They are thus 3° below the average of other mammals.

The marsupial whose temperature, so far as I have observed, comes next above the monotremes is the wombat, which stands at 34°·1, as the average of single observations made on two specimens (*Phascolomys lasiorhinus*, 34°·3, and *P. platyrhinus*, 34°). Next seems to stand the genus Petaurus, or flying squirrel. Mr. Ernest Le Souëf was good enough to observe for me the temperatures of five specimens in the Zoological Gardens of Melbourne. The average is 35°·7.

After that comes the genus Phascolarctos, our little native bears or koalas. I have kept numerous specimens of this animal (*P. cinerus*) on his native gum trees, with nothing artificial about him save a strap and rope whereby he could be pulled down from time to time to have his temperature observed. Thus I made eighty-three observations, the average of which amounts to 36°·4. Females at the breeding time are always very decidedly above the ordinary degree of warmth. If such cases be excluded, the average is exactly 36°. But the average for males alone is only 35°·2. The range of variation may be seen in Fig. 3.

The range is not very wide, yet I have often known healthy specimens that had been for a while in the sun stand as high as 37°·9, while on a cool day or in a very shady place the same individuals would be only 35°·3, a range greater than we would find under the same circumstances in any of the higher mammals. The highest register I ever obtained for a thoroughly healthy koala was 38°·4, which is a degree and a half above the normal temperature of man; the lowest was 34°·9, or nearly two degrees below man's normal.

According to observations taken for me by Mr. Ernest Le Souëf, the Dasyures come next at an average of 36°.

Phalangers stand next in order. The average of twenty-two observations on from two to four specimens of the ring-tailed opossums (Phalangista) gave 36°·6, which is only a little below the normal human temperature. But again the range was much greater than one finds in any of the higher mammals. In cool weather, with the thermometer at 16·8, a male would register about 35°, a female about one-tenth of a degree higher; but in warmer weather, though still in the shade, where the thermometer registered 31° to 35°, the opossums would be about 37°.

Mr. Ernest Le Souëf took for me the temperatures of three of these Australian opossums in the Melbourne Zoological Gardens. *Phalangista vulpina* gave 36°·1, *Phalangista fuliginosa* 37°·3.

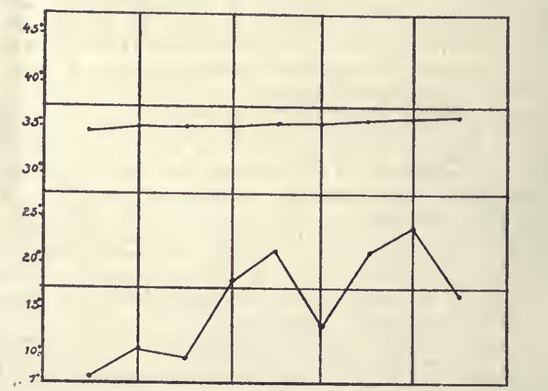


FIG. 3.—To show want of concomitance in the temperatures of Koala and air. Upper line, Koala; lower line, air.

This corresponds with Selenka's observations of the true opossums (Didelphys), which ranged about 37°.

I have made only four observations on the temperatures of the kangaroo family. They are a little under the human standard. *Macropus giganteus* gave 36°·6, *Halmaturus bennettii* gave 37°·1, *Petrogale xanthopus* 35°·9, while the tree kangaroo (*Dendrogalus grayi*) was exactly at the human standard, 37°.

From the few recorded temperatures of rodents and insectivores, I should think it most probable that they came next in order, with perhaps the Cetacea and Sirenia, judging from occasional records, as almost on the same level. All the other orders of mammalia stand uniformly much above the human temperature.

It is clear, therefore, that there are grades of temperature, and that the mammals which are classed lowest on anatomical grounds are not only of the lowest temperature, but also of the greatest range, and they are likewise, of all mammals, those which are under the strongest and most direct influence of the temperature of the environment.

Similar, though much less complete connecting links may be seen in the case of birds. The lowest of birds are the Ratitæ, or Cursores, and these appear to have the lowest temperature. Mr. Ernest Le Souëf took for me in the Melbourne Zoological Gardens observations on the temperature of the emu. These are the lowest records of bird temperatures of which I know. They averaged 39°·5, while all the birds above the Ratitæ are invariably over 40°. The temperature of thirty-six fowls, taken quietly by night from their perches, averaged 41° exactly, while that of twelve, lifted from the nests in which they were brooding,

was 41°·4. Numbers of fowls caught while roaming about averaged 41°·3, but these of course were always warmed up previously by a little violent exercise. Turkeys stand about the same level; ducks are stated, on good authority, to be lower; but I have found for these birds, from a fairly large number of observations, an average of 42°·1. The temperatures of birds of the more intelligent orders is generally somewhat higher. If we exclude the birds of prey, we might say that in all orders above the anseres, grallæ and gallinæ the temperature ranges over 42°. It would be a matter of interest to secure some observations of the temperature of the apteryx, in order to determine whether the lowest of birds shows by its body warmth in some degree the same reptilian affinity which the monotremes exhibit. In that case there would be reason to believe that the rest of the Ratitæ would correspond closely to the Marsupials, being a connecting link, but much closer to the higher forms than to the lower.

In a very general way, and not forgetting numerous limitations and contradictions, it may be said that bodily activity depends on body temperatures, that creatures such as insects and reptiles are active only when warmed up from without, but become torpid with decreasing temperature. The type in which activity is generally habitual, maintains its own body temperature. This is seen in the mammals, but more still in the birds. But this warm-blooded active condition was produced by no sudden emergence; the monotremes and marsupials form a gentle gradation between the reptile and the carnivore or ungulate: while, so far as indications point, there is reason to believe that the lower birds still are reminiscent of a once existent chain of links which equally joined the cold-blooded lizards to those warmest-blooded of all creatures, the passeriformes and fringilliformes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Dr. W. T. Brooks has been appointed Litchfield Clinical Lecturer in Medicine.

The Welsh Prize for Human Anatomy for 1897 has been awarded to Mr. A. T. Waterhouse.

W. K. Spencer, of Batley Grammar School, has been elected to a Demyship in Natural Science at Magdalen College, and A. J. Webb, of Dulwich College, to an Exhibition.

Convocation has conferred the degree of M.A., by decree, on Mr. A. A. Rambaut, the newly-appointed Radcliffe Observer.

Prof. Gotch and Dr. Buckmaster have been appointed Examiners in Physiology, and Prof. Allbutt and Dr. Ormerod in Medicine for the M.B. Examinations from 1898–1900.

Mr. N. V. Sidgwick, Ch. Ch., is President of the Junior Scientific Club for the present term. The other officers are: Treasurer, Mr. A. E. Boycott (Oriel); Editor, Mr. A. R. Wilson (Wadham); Secretaries, Mr. A. Hartridge (Exeter), and Mr. F. Nunneley (B.N.C.).

CAMBRIDGE.—Dr. Shore, of St. John's College, has been appointed Chairman of the Examiners for the Natural Sciences Tripos, and Dr. Hobson, of Christ's College, for Part II. of the Mathematical Tripos.

The Arnold Gerstenberg Studentship, for natural science students who distinguish themselves in Moral Philosophy, has been awarded to Mr. C. F. G. Masterman, of Christ's College.

By the will of Mr. Joseph Gedge, M.B., who died at Khartoum in 1870, while acting as medical officer to Sir Samuel Baker's expedition, a sum of 1000*l.* has now come to the University for the foundation of a biennial prize in Physiology. The recipient is to be a graduate of the University of not less than five or more than seven years' standing from matriculation, who sends in the best essay embodying original observations in physiology, including histology, physiological chemistry, and physiological physics. If the prize is not awarded on any occasion, the accumulated income of the fund is to be given to the Museums of Anatomy and Physiology.

At St. John's College the following awards in Natural Science have been made to students not yet in residence:—80*l.* scholarships, Williams, of Pocklington School, and Wakely, of St. Olave's School; 70*l.* scholarship, Gregory, of University College, Bristol; 50*l.* minor scholarships, Crocker, of Llandovery College, and Macalister, of Charterhouse; 50*l.* exhibition, Browning, of Dulwich College.

At Trinity College the corresponding awards are as follows:—75*l.* minor scholarship, Harrison, of Royal College of Science, London; 50*l.* minor scholarship, Hamill, of St. Paul's School; 40*l.* exhibitions, Keeling, of Bradford School, and Scott, of Rugby School; sizarship, White, of Royal College of Science, London.

THE death is announced of Dr. Arthur Scheffer, formerly professor of chemistry and medical physics in the University of Kieff.

THE Calendar for the seventeenth session (1897–98) of the University College, Nottingham, has just been published at Nottingham by Mr. J. Sands.

MR. ARTHUR HAMILTON WHITE has been appointed professor of pathology in the school of the Royal College of Surgeons, Ireland, in the place of Dr. Thomas Myles, resigned.

A LABORATORY for experimental psychology has been opened, under the direction of Dr. W. O. Krohn, in the Illinois Eastern Hospital for the Insane, at Hospital, Ill.

AT a meeting of the Court of the Victoria University, held at Owens College, Manchester, Prof. D. J. Leech was re-elected a member of the Council. It was resolved: "That the colleges of the University be invited to take such steps as may be necessary to secure the inclusion of the colleges in the list of institutions at which Royal exhibitions and national scholarships can be held."

THE Kingsley Laboratory of the Worcester Academy was dedicated on October 30. Addresses were delivered by President Eliot, of Harvard University; President Hall, of Clark University, and President Mendenhall, of the Worcester Polytechnic Institute. The building is said to be the best equipped for the study of science possessed by any secondary school.

GEHEIMER BERGRATH BRUNO KERL, professor of metallurgy at the Berlin School of Mines, has retired after more than fifty years constant professorial work at Clausthal and Berlin. He has been a voluminous contributor to the literature of metallurgy, and for thirty-eight years he was one of the editors of the *Mining and Metallurgical Journal* of Leipzig. On his retirement the German Emperor bestowed on him the Order of the Red Eagle in recognition of his great services to metallurgy.

THE following appointments abroad are noticed:—Dr. Charles W. Dabney, recently assistant secretary of agriculture, to be president of the University of Tennessee; Dr. Arthur Allin, of Ohio University, to be professor of psychology and pedagogy in the University of Colorado; Dr. Hermann Munk to be full professor of physiology in the University of Berlin; Dr. Hettner, of Leipzig, to be assistant professor of geography in the University of Tübingen, Dr. Max Busch to be assistant professor of analytical chemistry and chemical technology in the University of Erlangen; Dr. Zwaardemaker to be professor of physiology in the University of Utrecht; Dr. Frank K. Cameron, late associate professor of chemistry in the Catholic University of America at Washington, to be research assistant in physical chemistry in Cornell University; Dr. O V. Darbishire to be lecturer (privat-docent) in botany at the Prussian University of Kiel; Dr. A. R. Hill has been appointed to succeed Prof. Wolfe at the University of Nebraska. The chair vacated by Prof. Hill at the Osh-Kosh Normal School has been filled by the election of Dr. F. D. Sherman.

THE Report of the Council of the London Society for the Extension of University Teaching, for the session 1896–97, has reached us, and is of an encouraging nature. The number of courses for the session under review was 160, as compared with 148 for 1895–96, and the number of students for the two periods, in the order named, was 14,150 and 13,238. The slight falling off in the number of certificates awarded (1807 in 1896–97, as against 1906 in 1895–96) is explained by the alterations made in the Regulations of the Education Department with regard to the Queen's Scholarship Examination. Candidates are now only allowed to take the University Extension examination as an alternative to the Queen's Scholarship examination in the same subject, whereas formerly the possession of a sessional certificate secured a block of sixty marks in addition to those obtained in the ordinary examination. The Council anticipated

that this alteration would make a much greater difference in the number of pupil-teachers working for sessional certificates than has been the case. They have been much gratified by the enthusiasm shown by the heads of pupil-teachers' centres with regard to University Extension teaching, in their efforts to keep in connection with the Society under the altered conditions. Pioneer courses of lectures, the expenses of which have been borne by the Technical Education Board of the London County Council, have been given at Bethnal Green, Poplar, Queen's Park, St. Pancras, Shoreditch (two courses), Walworth (two courses), and Wandsworth. These courses were attended by about 3500 people, almost exclusively of the artisan class. The average attendance at each lecture was 387. In two of the districts regular extension centres have been formed as the result of the lectures. In connection with these courses the illustrations of scientific principles are largely drawn from the industrial developments of the district with which the working men are particularly acquainted. Thus the course on "Electric Power and Lighting," given by Dr. Laurie at the Town Hall, Shoreditch, in the Lent Term, was fully illustrated by views of the Shoreditch electric installation, and created an intense interest in the subject among the working men, who attended in great numbers. A large proportion of the audience remained for class instruction after the lectures; many did regular weekly paper work, and forty obtained the certificates of the Society as the result of the terminal examinatlon.

SCIENTIFIC SERIALS.

American Journal of Science, November. — Geology of Southern Patagonia, by J. B. Hatcher. This is an account of the results of an expedition into Argentine Patagonia made for the purpose of collecting vertebrate fossils for Princeton University. The oldest sedimentary deposits seen were a series of black, very hard, but much fractured slates, with Ammonites fairly abundant, but not sufficiently well-preserved to admit of identification. These beds are referred to the Jurassic, chiefly on account of their lithological characters and the great thickness of the overlying rocks, which, to judge from Dinosaurian remains, can hardly be more recent than the Cretaceous. The beds of basalt observed by Darwin on ascending the Santa Cruz River are not due to a flow from the distant Cordilleras, but to small local craters.—The former extension of the Appalachians across Mississippi, Louisiana, and Texas, by J. C. Branner. Gives additional facts in support of his thesis that the old Appalachian land area crossed what is now the lower Mississippi valley. The coal-measures drainage of the Illinois-Indiana-Kentucky basin flowed westward through the Arkansas valley into a carboniferous Mediterranean sea. The drainage of the coal-measures region south of the Ouachita anticline flowed westward and entered this sea north of the Texas pre-Cambrian area. The drainage of both the Arkansas and Texas carboniferous areas was reversed about the end of Jurassic times, when orographic movements over south-east Arkansas, eastern Texas, Louisiana, and Mississippi submerged the former extension of the Appalachian watershed, and admitted the early Cretaceous sea across the Palæozoic land as far north as southern Illinois.—The combustion of organic substances in the wet way, by I. K. Phelps. Carbon dioxide may be estimated iodometrically with a fair degree of accuracy. It may, therefore, be applied to the determination of organic carbon oxidised by liquid reagents, such as potassium permanganate or chromic acid. The former was used for oxidising oxalates, formates, and tartar emetic; the latter for these and cane-sugar and paper. The method is very successful in the case of the less volatile organic compounds.—Some features of the pre-glacial drainage in Michigan. In all the glaciated area of North America no region is so extensively and deeply covered with drift as the lower peninsula of Michigan. The author works out the probable features by analogy with unglaciated areas, and constructs a map showing the probable carboniferous river system.

Wiedemann's Annalen der Physik und Chemie, No. 10.—Observation of Zeemann's phenomenon, by W. König. The author observes the dark sodium lines produced by an arc light traversing a sodium flame. The broadening in a magnetic field is detected by a differential method. A quarter-wave plate and a doubly-refracting prism are used to obtain two images of the slit joining across a narrow line. The extinction of the circularly-polarised right-hand edge in one image, and the left-hand edge in the other, gives the appearance of a lateral displacement which is reversed by turning the prism. A total displacement of 1/28th of the distance between the D lines is thus obtained in a field of 7300 units.—On the rate of depolarisation of electrodes and on dielectric constants at low temperatures, by R. Abegg. This is a criticism of Dewar and Fleming's alleged enormous capacities of certain dielectrics at very low temperatures. The author maintains that these are only apparent, and are really due to the very slow depolarisation of electrodes in great cold, so that the current obtained from the condenser is a polarisation current instead of being a dielectric current.—On the depolarisation of mercury and platinum electrodes, by K. R. Klein. Large and small electrodes dipped into various acid and salt solutions, and the course of their polarisation by a known E.M.F. and their subsequent depolarisation, was investigated by means of a capillary electrometer of negligible capacity. It was found that the rate of depolarisation was nearly independent of the area of the electrode and of the nature of the solution, but was much accelerated by heat and by the presence of a salt composed of the electrode metal as a base, and the acid of the electrolyte.—An electro-chemical method of converting alternating into direct currents, by L. Graetz. Cells in which aluminium forms the anode do not transmit currents having a voltage below 22. Alternating currents may therefore be converted into intermittent currents by means of a battery of such aluminium cells. The author describes an arrangement for obtaining a direct pulsating current by the same means The apparatus forms a convenient "rectifier."—Researches on lampblack, by J. Stark. The specific gravity of solid lampblack is forty-three times that of lampblack as deposited. One cc. contains 1,270,000 million particles of lamp black. The author obtained polished surfaces of lampblack, and proved that as regards elliptic polarisation they occupy a place intermediate between transparent substances and metals.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 12.—Mr. G. Johnstone Stoney, Vice-President, in the chair.—Mr. J. Rose-Innes read a paper on the isothermals of ether. The well-known generalisations of Boyle and Gay-Lussac with regard to the pressure, volume, and temperature relations of gases, were examined by Ramsay and Young, who deduced the law $p = bt - a$, *i.e.* that pressure is a linear function of temperature, at constant volume, where b and a are functions of volume only. It yet remains to discover the form of these two functions b and a. The author finds b and a for a large number of volumes, and from them devises an empirical formula. As a preliminary step he examines whether any single algebraical expression can represent the case, so as to determine the probability of discontinuity. For this purpose a graphic method is applied. By plotting $(av^2)^{-1}$, against $v^{-\frac{1}{3}}$, a curve is obtained of "cusp" shape. The point of the cusp occurs very near critical volume, it suggests discontinuity in the slope of $(av^2)^{-1}$. The author concludes that there is extremely rapid change of behaviour of the gas at this point. Again, it is known that the temperature at which pressure is accurately given by the laws of a perfect gas at a particular volume, is constant for large volumes until critical volume is approached. The author observes that at the critical volume this temperature diminishes somewhat from its value for large volumes. These conclusions were embodied in a previous paper, and an algebraical expression for pressure in terms of temperature and volume were then given for isopentane. In the present paper the author investigates a similar formula for ether. Prof. Ramsay said that experimental errors might account for some of the lack of agreement between proposed formulæ and direct observation of the behaviour of gases. Isopentane was probably a better-investigated body than ether, for it was simpler. Ether tended to form complex molecular groupings, but isopentane was probably a mono-molecular liquid. Prof. Perry did not quite agree with the author's conclusions. It was necessary to distinguish between a formula founded on a physical hypothesis, and a mere empirical formula. The author had assumed that the Ramsay and Young formula was very exact, its originators did not put it forward as being infinitely exact. Probably the best test for such a formula as that under discussion would be derived from some thermo-dynamical conclusion deduced from it. The Rose-Innes formula, with five constants

and implying discontinuity, was to be distrusted, for there was no such thing as discontinuity in the problem. In any case, an empirical formula should have a very simple form. Mr. Rose-Innes admitted that a formula founded on sound hypothesis was to be preferred to empirical expressions. But mathematicians had not yet provided an hypothesis applicable to a substance whose molecular arrangement was so complicated as that of ether. Mathematicians must, therefore, improve their methods before working formulæ could be deduced from their hypotheses. The use of an empirical formula with five constants was justified by Kepler for the planetary orbits. Kepler used that formula with no other justification than his experience that an ellipse fitted his observations better than a circle. Similar instances might be cited from recent work on the theory of solution, and osmotics. Mr. Johnstone Stoney was disposed to look for a mathematical cause for the cusp; it was improbable that the physical change was so abrupt as that represented graphically by the author. The question might be tested by plotting the two curves $y = v^{-\frac{1}{3}}$ and $y = a v^2$, and by observing whether these also suggested discontinuity.—Mr. W. L. Waters then read a paper on the variations in the E.M.F. of the H-form of Clark cells with temperature. The authors, Messrs. F. S. Spiers, F. Twyman, and W. L. Waters, have investigated how nearly the true E.M.F. of Clark cells can be computed at different temperatures by applying the ordinary temperature correction. As a standard, two cells of the Muirhead type are employed. The four cells under test could be put through cycles of temperature in a special heating bath, containing oil circulated by a centrifugal pumping vane. E.M.F.s were determined by a potentiometer method, and a careful study was made of the "lag" of E.M.F. behind temperature. The results are given in the form of curves. It is shown that "lag," in the H-form of cell, is less than in the "Board of Trade" form. Under ordinary conditions, when the rate of variation of temperature is less than 2° C. per hour, by applying temperature-corrections the true E.M.F. of the H-form can be found to within a ten-thousandth of a volt. In this respect there is little to choose between the H-form and the "Muirhead" cell. Mr. W. R. Cooper thought the authors did not express the case clearly. The E.M.F. of the "Board of Trade" cell could not, with reason, be itself stated within 1 per cent. But in some cases when, for instance, cells were used differentially, greater accuracy might be required, as, for instance, when a constant source of E.M.F. was being compared with the variations of another source. Here it might be necessary to know the "lag." He would like to know with what degree of accuracy the E.M.F. of the standard cell was determined by the authors. The lag that occurred in the "Board of Trade" cell was probably due to diffusion, crystallisation, and solution.—Mr. Waters said the E.M.F. of the standard was measured by a Kelvin balance to one in ten-thousand.

Entomological Society, November 3.—Mr. R. Trimen, F.R.S., President, in the chair.—Mr. Selwyn Image was elected a Fellow of the Society.—Mr. J. J. Walker exhibited specimens of *Anisolabis annulipes*, Luc., an introduced species of earwig taken among bones at the chemical works at Queenborough, and of *Brachysomus hirtus*, Boh., a rare weevil, taken among dead leaves at Chatham.—Mr. Janson exhibited a variety of *Melanargia galatea* of a clear yellowish cream colour, without trace of the usual black markings. It was captured between Dover and Walmer in 1843, and was still in very perfect condition.—Lord Dormer showed a remarkable openwork cocoon of an unknown Japanese moth, constructed from the larval hairs.—Mr. Jacoby exhibited fine examples of both sexes of the Australian Hepialids, *Charagria ramsayi*, *C. splendens* and *Hepialus daphnandri*.—Mrs. Nicholl exhibited a selection from the butterflies collected by her this year, in June and July, in the Albarracin Mountains in Aragon, containing several additions to the list of the district published in Madrid by Don Zapater and Herr Max Korb. The species of greatest interest were *Erebia zapateri*, Oberth., *Cœnonympha iphioides*, Staud., *Satyrus prieuri*, Pier., and its fulvous ♀ var. *uhagoni*, which was observed to be much more attractive to the males than the normal form was; *Argynnis hecate*, Esp., and *Parnassius apollo*, L., of which a female variety occurred with red-centred ocelli on the upperside of the forewing.—The Rev. H. S. Gorham showed examples of the following rare beetles from the New Forest: *Notiophilus rufipes*, *Velleius dilatatus*, *Trichonyx sulcicollis*, and *Lytta vesicatoria*.—Mr. Tutt showed a series of Noctuæ, taken at Romford by the Rev. W. Claxton, all of aberrant form; and for Mr. J. Merrin a specimen of *Aglais urticæ* with a silvery costal spot on the underside of the forewings, a series of *Melitæa aurinia*, and an example of *Syrichthus malvæ*, ab. *taras*, taken near Gloucester.—Mr. Kirkaldy exhibited a complete series of species of the genus *Notonecta*, L., specimens of the larva and imago of the very rare *Deinostoma dilatatum*, Say., from Arizona, and specimens of *Antipalocoris marshalli*, Scott, from Ceylon, which was previously recorded from Corsica alone.—Papers were communicated by the President on new or little-known species of African butterflies, and by Mr. E. Meyrick on new Lepidoptera from Australia and New Zealand.

CAMBRIDGE.

Philosophical Society, November 8.—The following communications were made:—On a method of demonstrating assimilation in green plants, by Mr. F. Darwin, President. Farmer has shown that the protoplasm ceases to circulate in an Elodea leaf subjected to a stream of hydrogen and kept in the dark; also that if the preparation is illuminated the circulation begins again. The cessation of the circulation depends on the protoplasm being deprived of oxygen, the reappearance of the movement is a consequence of the fresh supply of oxygen yield by the chloroplasts in light. The experiment can be more simply performed by mounting in water two or three Elodea leaves under a single cover-glass, and sealing the preparation with melted wax and paraffin. The leaves if kept in the dark begin after a few hours to suffer for want of oxygen, and after six or seven hours the protoplasm ceases to circulate. The movement may be restored by exposing the preparations to sunlight or to incandescent gas flame. Thus a demonstration, in its way as interesting as Engelmann's bacterial method, may be very simply performed.—Artificial cultures of *Stereum*, a timber-destroying fungus, by Prof. Marshall Ward.—On *Encephalartos ghellinckii*, Lem., a rare Cycad, by Mr. A. C. Seward. The author gave a short description of a plant of *Encephalartos ghellinckii*, Lem., which had been obtained by Mr. Lynch, of the Botanic Gardens, from Messrs. Saunders, of St. Albans. This species differs in the form of the frond from the better-known examples of the South African Cycadean genus *Encephalartos*, and presents certain features which are of importance from a palæobotanical point of view.

MANCHESTER.

Literary and Philosophical Society, November 2.—Mr. J. Cosmo Melvill, President, in the chair.—Prof. Boyd Dawkins, F.R.S., exhibited a section of a spruce trunk which had been completely hollowed out by a polysporous fungus. The resinous pine-knots, however, are left entire, radiating from the centre. He also pointed out that similar pine-knots (which he examined in the museum at Basle) found in the interglacial deposit of Darnten, and considered by Profs. Rütimeyer and Schwendauer to be the remains of old basket-work or wattle-work, and to prove the existence of interglacial man, are merely the result of the nature decay of the wood, and are not artificial. He also showed, under the microscope, a section of Fardel coal, showing a resinous stem or knot from a carboniferous plant, the rest of which has gone to form the black substance of the coal. Prof. F. E. Weiss made some remarks on the exhibit, attributing the destructive action to the fungus *Trametes pini*, and explained how the fungus attacked the centre of the tree, making its way in through the decayed core of broken branches.—Prof. Weiss then exhibited a specimen of *Plowrightia morbosa*, the black-knot, on a branch of cherry collected in Canada, where it has been the cause of considerable destruction of cherry-trees. He also exhibited the fructifications of *Peziza æruginosa*, the green-rot of the oak. The fructifications of this fungus, which are rarely met with, were collected at New Abbey, near Dumfries. A discussion followed, which also turned on the subject of the colouring-matter of fungi.—Prof. H. B. Dixon, F.R.S., exhibited and remarked upon a number of lantern photographs of explosion-flames.

PARIS.

Academy of Sciences, November 8.—M. A. Chatin in the chair.—On the influence of hygroscopic substances upon the combination of hydrogen and oxygen, by M. Berthelot. The hygroscopic substances chosen were hydrogen chloride, boron fluoride, and sulphurous anhydride as giving homogeneous systems for liquids, concentrated sulphuric acid; for solids, phosphorus pentoxide, baryta, quick-lime, and potassium hydroxide. Of these the three gases were found to be without appreciable effect in accelerating the reaction; with sulphuric acid, the

hydrogen alone disappeared at 280°, owing to its reacting with the acid. In the case where phosphorus pentoxide was present, the rate of combination was of the same order of magnitude as when the mixture was heated alone. The conclusion is drawn that there is no equilibrium corresponding to the vapour pressure of the water produced, but that the reaction, although very slow, is unlimited.—On an explanation applicable to the phenomena of Faraday and of Zeeman, by M. Henri Becquerel. Starting from the hypothesis that in a magnetic field the ether possesses a vortex-movement of given period, θ, the conclusion is drawn that in the Zeeman phenomenon the variation of the wave-length ought to be proportional to the square of the wave-length. The value of the reciprocal of θ is calculated both from the Zeeman and Faraday effects, the numbers for air showing a good agreement in the two cases.—Study of the oysters of Cette, from the point of view of pathogenic micro-organisms, by MM. Ad. Sabatier, A. Ducamp, and J. M. Petit. No pathogenic organisms could be found in oysters after exposure for some time to water containing sewage. Even when cultures of the typhoid and *Coli communis* bacilli were injected into living oysters, no trace of either could be detected after four days in sea water. The authors conclude from these experiments that there is no ground for considering oysters as one of the causes of typhoid fever.—The Perpetual Secretary announced to the Academy the loss sustained by science by the death of M. Scheering.—Observations on the Perrine comet (October 1897) made at the Observatory of Algiers, by MM Rambaud and Sy.—On the general theory of functions of real variables, by M. R. Baire.—On the potential of the double layer, by M. A. Liapounoff.—On the mechanism of rotatory magnetic polarisation, by M. André Broca.—On the variation of energy in isothermal transformations; electric energy, by M. H. Pellat.—The dissemination of the X-rays, by M. Abel Buguet. By the use of protecting leaden screens, in cases where a long exposure is required, a much clearer photograph is obtained.—On the molecular volumes and densities of gases in general at all temperatures and mean pressures, by M. A. Leduc.—Table of the elements, arranged with the atomic weights in multiple proportions, by M. H. Wilde.—On some new lines in the spectra of oxygen and of thallium, by M. H. Wilde.—On the action of nitric acid upon tin, by M. R. Engel.—Estimation of phenylhydrazine, by M. H. Causse. The method proposed is based upon the reduction by the phenylhydrazine of arsenic to arsenious acid, and the iodometric estimation of the latter.—New combinations of phenylhydrazine with mineral salts, by M. J. Moitessier. The salts described are compounds of phenylhydrazine with the chlorides and sulphates of nickel and cobalt, and cobalt bromide. They contain more phenylhydrazine than the series previously described.—Biological preparation of levulose from mannite, by MM Camille Vincent and Delachanal. The ferment of sorbose, developing in a solution containing mannite, oxidises the latter to levulose.—On some halogen derivatives of methyl-phenyl ketone, by M. A. Collet. The preparation and properties of

$$C_6H_4Cl.CO.CH_2Cl\ [1:4],\ C_6H_4Br.CO.CH_2Cl\ [1:4],$$
$$C_6H_4Cl.CO.CH_2Br\ [1:4],\ \text{and}\ C_6H_4Br.CO.CH_2Br\ [1:4]$$

are described. — On caroubinose and *d*-mannose, by M. Alberda van Ekenstein. The sugar described as new by M. J. Effront (August 2, 1897), obtained from the grains of *Ceratonia siliqua*, is identical with *d* mannose.—Vegetation with and without argon, by M. Th. Schlœsing, jun. No difference could be observed in the growth of the plants in the two cases, and no measurable amount of argon was absorbed.—On Strongylosis observed at the Agricultural School at Grignon, by M. Ch. Julien.—On the production of gum in the Sterculiaceæ, by M. Louis Mangin.—On the periods of development of the black rot in the south-east of France, by M. Joseph Perraud.—On the diseases of the bulbs of *Crocus sativus*, L., by M. E. Roze.—Researches on the formation of oil reserves in seeds and fruits, by M. C. Gerber.—On the absorption of carbon monoxide by the blood of a living mammal, by M. N. Gréhant. The experiments showed that for air containing 1/6000th of its volume of carbon monoxide or less, the volume absorbed by 100 c.c. of blood was proportional to the time. For stronger mixtures (·001) a limit appeared to be reached after about three hours.—On the histological modifications of nerve cells in a state of fatigue, by M. Ch. A. Pugnat. Fatigue in the nerve cells is accompanied by a diminution in volume of the cellular body and the nucleus, and by the disappearance of the chromatic substance of the protoplasm.—Intermediate forms in cartilaginous tissue, by M. Joannes Chatin.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 18.

ROYAL SOCIETY, at 4.30.—Account of a Comparison of Magnetic Instruments at Kew Observatory: C. Chree, F.R.S.—Note on the Influence of very Low Temperatures on the Germinative Power of Seeds: H. T. Brown, F.R.S., and F. Escombe.—On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. II. On *Spencerites*, a New Genus of Lycopodiaceous Cones from the Coal Measures, founded on the *Lepidodendron Spenceri* of Williamson: D. H. Scott, F.R.S.—The Histology of the Cell-wall, with special reference to the Mode of Connection of Cells: W. Gardiner, F.R.S.—Mathematical Contributions to the Theory of Evolution. IV. On the Probable Errors of Frequency Constants, and on the Influence of Random Selection on Variation and Correlation: Prof. K Pearson, F.R.S., and L. N. G. Filon—On the Geometrical Treatment of the "Normal Curve" of Statistics, with especial reference to Correlation, and to the Theory of Error: W. F. Sheppard.

LINNEAN SOCIETY, at 8.—On *Pontobolbos manaarensis*: Prof. A. Dendy.—On Haddonia, a New Genus of Foraminifera: F. Chapman.

CHEMICAL SOCIETY, at 8.—On the Decomposition of Camphoric Acid by Fusion with Potash or Soda: Dr. A. W. Crossley and W. H. Perkin, jun., F.R.S.—Experiments on the Synthesis of Camphoric Acid: W. H. Bentley and W. H. Perkin, jun., F.R.S.—The Action of Magnesium on Cupric Sulphate Solution: Dr. Frank Clowes and R. M. Caven.—Properties and Relationships of Di-hydroxytartaric Acid: H. J. Horstman Fenton.

CAMERA CLUB, at 8.15.—Seismograms and Telegrams: Prof. Milne, F.R.S.

MONDAY, NOVEMBER 22.

CAMERA CLUB, at 8.15.—Electric Waves, illustrated by Telegraphy without Wires. A. Campbell.

TUESDAY, NOVEMBER 23.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Central Station Electric Coal Mining Plant in Pennsylvania: W. S. Gresley.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Photographs of the Optical Projections in Space produced by the Aerial Graphoscope; Probable Projection of Lightning Flashes, illustrated by Experiments and Photographs: Eric Stuart Bruce.

ANTHROPOLOGICAL INSTITUTE, at 8.30.

LEIGH BROWNE TRUST AND THE HUMANITARIAN LEAGUE (St. Martin's Town Hall, W.C.), at 8.—The Germ Theory and its Fallacies: Dr. Campbell Black.

WEDNESDAY, NOVEMBER 24.

SOCIETY OF ARTS, at 8.—Progress of Metallurgy and Metal Mining in America during the last Half-Century: Prof. James Douglas.

THURSDAY, NOVEMBER 25.

ROYAL SOCIETY, at 4.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Accumulator Traction on Rails and Ordinary Roads: L. Epstein. (Continuation of Discussion.)

CAMERA CLUB, at 8.15.—Photographic Action Writ Large: a Kurveylinear Conversation on Corn: Prof. Armstrong, F.R.S.

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THURSDAY, NOVEMBER 25, 1897.

VOLCANOES OF NORTH AMERICA.

Volcanoes of North America; a Reading Lesson for Students of Geography and Geology. By Israel C. Russell, Professor of Geology, University of Michigan, Pp. xiv + 346. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1897.)

PROF. RUSSELL'S beautiful volume is, in some sense, a companion to Sir Archibald Geikie's account of the volcanoes of Great Britain; but whereas the latter deals with volcanic relics of all ages in an area the whole of which has been studied in considerable detail, the former has to do only with still active volcanoes, or such as have been in activity since the beginning of the Tertiary era, while in many of the districts dealt with but little scientific information is available.

The first chapter contains a most useful summary of the general characteristics of volcanic action all the world over, culled from the work of authorities like Judd, Palmieri and Shaler, Verbeek, Dutton and Dana, followed by an account of the shape and structure of cones, and the different rock products formed by volcanic action. American volcanoes do not enter much into this account, but touches of local colour are not altogether absent, for we learn that "while Vesuvius is regarded as a very obstreporous volcanic vent, its performances are mere Fourth of July fireworks in comparison with the Day of Judgment proceedings of Krakatoa."

In dealing with masses of intrusive rocks the author distinguishes between dykes, sills, laccolites, plugs, and *subtuberant* mountains, the last term applying to great sculptured domes like the Black Hills of Dakota, known to be based in an enormous core of granite which appears to have slowly increased in bulk like "the growth of a tuber in the earth" and lifted the sediments upon its back.

The next three chapters are devoted to the volcanoes of North and Central America. The author does not appear to have visited Central America, Mexico, or Alaska north of Cook's Inlet, and in his description he is further hampered by the absence in many cases of recent or trustworthy scientific information. Considering this disadvantage the account given is a very useful one, and as much care has been taken to exclude untrustworthy information as to make the most of what is good. In spite of Humboldt's authority, Prof. Russell thinks the story that Jorullo arose in a night is not worthy of credence. Izalco, in Central America, however, appears to have acquired its total height of 3000 feet above the surrounding country since 1770.

Passing on to the volcanoes of the United States, Prof. Russell at once finds himself at home and amongst examples which he has personally studied. His account becomes more graphic and full of the results of close and careful observation. Beautiful examples of denuded rocks standing as columnar rock pillars are associated with the lava sheets forming "mesas" or plains about Mount Taylor in New Mexico. The oddly-named Ice-Spring Craters in Utah seem as perfect as those of Auvergne, and illustrate some strange phases of eruption. The lake of molten lava in one of the craters appears to have slowly risen to a considerable height before breaking out an exit for itself, and relics of its former levels still exist in five terraces inside the crater ring. One of the lavas, too, though lying in a depressed channel, evidently "spread beyond its channel like an aqueous stream, and deposited, not its sediment, but its crust."

Many interesting features of the craters near and in Monro Lake, California, are described; but we have only room for one or two of the observations. Granite pebbles occur in the tuffs, evidently thrown up from a gravel sheet through which the volcano burst; one of the lava streams when looked at from above is seen to have its scoria ridges arranged like curved terminal moraines; the lavas are mainly obsidians, and remain as plugs, more or less filling some of the craters, and even in certain instances rising higher than the crater rim without overflowing; where it did outflow, the lava was highly viscous, and was pushed forward in thick sheets, terminating in precipices between 200 and 300 feet high. The beautiful cone of Mount Shasta in California, of which a picture is given, has not been long extinct, for its most recent lavas are not glaciated. Yet one of them entered the cañon of the Sacramento River, reaching a distance of fifty miles, and the river has since cut through this barrier and excavated a narrow gorge more than a hundred feet deep in the rocks beneath. A still more remarkable case of erosion is quoted from an extinct volcano near Fort Union in New Mexico, where a lava filled up the Mora cañon to a depth of 400 feet. The river has re-excavated this channel, and cut down 230 feet into the rock beneath. "The time required for Niagara to cut its gorge . . . has been variously estimated at from 7000 to 35,000 years." "In comparison with Niagara, it is safe to say that 150,000 to 200,000 years have passed since the lava plunged in a fiery flood into the gorge of the Canadian [River]." The descriptions of Crater Lake, Oregon, and the extinct snow-clad giants of the Cascade Range, set amongst their dense forests like a "belt of emerald studded . . . with immense brilliants," must be passed over, as well as the admirable accounts of the vast lava fields of the Columbia and the volcanoes of the Rocky Mountains, though they are full of good points.

A chapter is devoted to the noteworthy deposits of volcanic ash and dust, some of which locally attain a depth of fifty feet, and spread over such areas as 10,000 and even 53,000 square miles. These indicate that "disasters similar to those accompanying the eruptions of Conseguina and Krakatoa occurred at intervals throughout the Tertiary and Recent history of fully one-half of North America," leaving their traces in tracts of fertile soil and deposits of considerable economic value.

In his chapter on "Theoretical Considerations," Prof. Russell adopts the idea of "potential plasticity" of the earth's interior. From this he derives the pressure which brings molten matter to the surface, relegating to quite a secondary place the influence of steam. For many reasons he considers steam an accidental and non-essential constituent of lava, obtained by it when coming

into contact with water-saturated rocks. The association of volcanoes with ocean-margins he considers to be due to the fact that both classes of phenomena mark planes of weakness in the earth's crust. This chapter is well deserving of careful study, and the final one presents an interesting sketch of the chief events which mark the life-history of a volcano.

The book is carefully written, and well illustrated by maps and process-blocks from photographs. It would be a convenience if some simple mark had been used to indicate on the large map those volcanoes which have been active within recent times. W.

THE PRINCIPLE OF CONSERVATION OF ENERGY.

Das Princip der Erhaltung der Energie und seine Anwendung in der Naturlehre. Von Hans Januschke. Pp. x + 456. Medium 8vo. (Leipzig: B. G. Teubner, 1897.)

THOSE who are engaged in teaching applied mathematics cannot fail to appreciate the wide advantages arising from according greater prominence to the principle of conservation of energy than it obtained in the text-books of the last generation. Unfortunately, however, this principle, when stated in the restricted form in which it is most easily understood—viz. the mere assertion of constancy of the total energy, kinetic and potential, of a material system—is insufficient of itself to determine the actual motion of systems with more than one degree of freedom, and, moreover, cannot be applied to find the passive reactions arising from constraints. This particular point has been brought out forcibly in the recent controversy on "energetics" in which Boltzmann, Planck, Helm and others have taken part. Some further assumption or generalisation is necessary; either the principle of physical independence of force, or the extension of the principle of energy to virtual displacements (*i.e.* the principle of virtual work), or the hypothesis that the equation of energy holds good separately for every particle of a material system for the components of motion in every direction, or the assumption of the variational equation, or the principle of least action; all these alternatives are practically equivalent, and enable us to construct an energy theory of dynamics. Only quite recently Prof. Boltzmann, writing in *Wiedemann's Annalen*, suggested the possibility of building up the equations of motion, first of rigid bodies, and then of fluids and elastic solids, from the principle of energy aided by suitable subsidiary hypotheses; and the present volume is interesting as showing how this method works out when applied to a somewhat elementary text-book.

We fear that Herr Januschke hardly emphasises sufficiently the subtle difference between the restricted form of the principle and these necessary generalisations. At any rate, his deduction of d'Alembert's principle (p. 42) strongly reminds us of Clerk Maxwell's proof of the Lagrangian equations ("Electricity and Magnetism," vol. ii. § 561), the fallacy in which has been pointed out by Prof. J. J. Thomson. If we differentiate the equation of energy

$$W_0 + \Sigma(Fh + \tfrac{1}{2}mv^2) = \text{constant}$$

with respect to the only independent variable, the time t, where $dh/dt = v$, we obtain

$$\Sigma\left(F\frac{dh}{dt} + mv\frac{dv}{dt}\right) = 0,$$

whence, by taking account of the fact that (according to Herr Januschke) dh and dv are of opposite signs, it is possible to write down the equation

$$\Sigma\left(F - m\frac{dv}{dt}\right)dh = 0.$$

But here $dh = vdt$, and so the variations dh are not all independent, but their ratios are connected by relations of the form

$$\frac{dh_1}{v_1} = \frac{dh_2}{v_2} = \frac{dh_3}{v_3} = \ldots$$

There is here no justification for the inference that such an equation will hold for variations other than such as are connected by this relation, *i.e.* for displacements other than those the body really undergoes. As regards the change of sign mentioned above, comment is superfluous.

In treating projectiles, the principle of independence of motions is assumed, and with this aid no difficulty occurs. But we naturally pass on to the treatment of "centrifugal force" as a more crucial test of the energy method, and here we find the result obtained either by a wholesale disregard of algebraic signs, or at any rate by what appears to an ordinary reader as such. Taking two particles m_1 and m_2 connected by a string of length $r_1 + r_2$ and revolving in circles of radii r_1 and r_2, the kinetic energy is

$$W = \tfrac{1}{2}m_1v_1^2 + \tfrac{1}{2}m_2v_2^2.$$

For equilibrium the author writes down from this:

$$dW = m_1v_1dv_1 - m_2v_2dv_2 = 0$$

(why the sign of the second term should be changed is not obvious). Hence he infers that the tension in the string is

$$p = m_1v_1\frac{dv_1}{dr} = m_2v_2\frac{dv_2}{dr}.$$

Putting $v = rw$ where w is the angular velocity, he gets for the centrifrugal force

$$p = \frac{m_1v_1^2}{r_1} = \frac{m_2v_2^2}{r_2}.$$

This result is obtained on the supposition of v being directly proportional to r. But in the theory of central orbits, it is known that unless work is done on the particle by tangential forces, the angular momentum, and not the angular velocity, is constant, and hence v ought to be taken inversely proportional to r, which would reverse the sign of the result. Hence Herr Januschke's method really makes the normal acceleration tend in the wrong direction.

After dealing with rigid bodies, the equilibrium and motion of fluids are considered; but this portion does not extend to the general equations of hydrodynamics (where we should have most liked to see how the "energetic" method works out), Torricelli's theorem and the hypothesis of parallel sections being alone considered. Gases follow next, then a chapter on "molecular forces" dealing with elasticity and capillarity. Chapter v. deals with heat, and includes a very fair exposition of the first and second laws of thermodynamics, the subject being opened

by a simple mechanical analogue, by means of which the conception of absolute temperature is introduced. The determination of specific heats, properties of gases, change of state, Van der Waals's equation, and the critical point are well treated, and an attempt is made to explain the phenomena from the molecular standpoint, so far as this can be done by general reasoning. The author's treatment of thermodynamics, however, does not present any striking divergence from the conventional standpoint in which conservation of energy necessarily occupies a prominent position. Of the chapters on electricity, magnetism and light, we can only say that they appear to form a concise and convenient introduction to the elementary principles of the subject.

As an introductory sketch of the outlines of natural philosophy, the book may be unhesitatingly recommended. The wide range of ground covered renders the treatment somewhat encyclopædic, but a notable feature is the large amount of historical information with which each chapter opens. This alone makes the volume valuable as a work of reference.

Another excellent feature is the large number of examples on nearly every section. Many of these are straightforward numerical calculations based on the bookwork, nearly all of them illustrate some point of physical interest. But it is a pity that the student after reading the question sees the answer before him, instead of having an opportunity to work it out for himself; these answers would be much better placed at the end of the book.

Whether Herr Januschke has succeeded or not in establishing the superiority of the "energetic" method, there can be no doubt that he has produced a text-book which will prove of great use to students, and still more to teachers of physics. G. H. BRYAN.

THE FERTILITY OF THE LAND.

The Fertility of the Land. By Isaac P. Roberts. Pp. xvii + 415. With forty-five illustrations. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897.)

THE sub-title of this volume, "A summary sketch of the relationship of farm-practice to the maintaining and increasing of the productivity of the soil," conveys a comprehensive idea of its scope. It belongs to the Rural Science Series, and Mr. L. H. Bailey, who contributes the preface, bestows upon the book a sort of editorial benediction when he commits himself to the statement, "It is the ripened judgment of the wisest farmer whom I have known." The editor further remarks,

"I confess that I have looked with some apprehension upon the rapid diffusion of experimental science of recent years, for there is danger that this knowledge may overshadow the importance of accustomed farm-practice, and lead the farmer to demand specific rules for each perplexity, and to depend upon the Experiment Station and the teacher for his farming."

The fifteen chapters deal with the following subjects: (1) an inventory of the land; (2) the evolution of the plough; (3) tilling the land; (4) conservation of moisture; (5) irrigation and drainage; (6) farm manures; (7) manures produced by various animals; (8) the waste of manures; (9) the care, preservation and application of manures; (10) nitrogen and nitrification; (11) the phosphoric acid and potash supply; (12) commercial fertilisers; (13) lime and various amendments; (14) green manures and fallows; (15) rotations. The treatment of the subject is thus seen to be fairly discursive, and the omission of, for example, the second chapter on the evolution of the plough would in no way have detracted from the main object of the volume. It may be noted in passing that the part of the implement which is familiarly known in this country as the skim coulter is designated the "jointer or skim plough" by the author; we think the English name is preferable as being more descriptive. Much valuable information is brought together in the volume in a convenient form, whilst most of the assertions made by the author, though they may not always carry conviction, are suggestive in character and calculated to stimulate useful trains of thought in the student's mind. The chief defect of the volume is that it ignores the epoch-making work in which Lawes and Gilbert have been engaged for more than half a century. Neither their names nor the name of Rothamsted are mentioned in the index, nor do we come across any reference to them in the text. As the author, we are told, "has had the advantage of much travel," we can only suppose this omission is intentional. The book, of course, suffers in consequence; to give only one instance, the author has missed entirely the admirable definitions of "fertility" and "condition" as applied by Lawes to the soil, and as usefully adopted for practical purposes by English farmers. That the writer is not altogether successful in his selection of authorities is further apparent from the circumstance that he betrays no knowledge of the researches of Warington in nitrification. There is evidence, however, of much familiarity with continental work, and the title of the thirteenth chapter, "lime and various *amendments*," has an unmistakably French flavour. The book is well printed and neatly turned out; but the Englishman who respects his mother-tongue will experience a shudder at the strange spectacle presented by certain familiar words spelt in "American."

CRIME AND CRIMINALS.

Crime and Criminals. By J. Sanderson Christison, M.D. Pp. 117. (Chicago: The W. T. Keenen Company, 1897.)

DR. CHRISTISON has been attracted to a subject full of difficult problems, but he makes no very practical contribution to their solution. He is a student in the school of Lombroso, and has been at some pains to investigate the psychological aspects of the criminal The cases he presents are, many of them, interesting enough; but beyond proving the fact that the types of offenders are much the same all the world over, they serve no particular purpose, and they are certainly not sufficient to justify the main point of his book—that our existing penal methods are a failure. He has been helped to this conclusion, moreover, by the single experience of the United States where, in his own words, "crimes are now nearly five times as numerous

as forty years ago." The criminal statistics of other countries, notably of England and Belgium, can happily show different figures, judging by the numbers incarcerated now and in previous years, the only trustworthy test indeed. Dr. Christison seems inclined to lay too much stress upon prison systems as affecting the increase and decrease of crime. Where they are manifestly bad, as it is to be feared they are in a very large proportion of cases in the United States, they may manufacture criminals. For example, there is no more fruitful source of crime than the indiscriminate association of prisoners of all classes and categories which is still very general in American prisons. For one Elmira, with its ultra-tenderness for the dishonest, there are hundreds of county gaols where no sort of care is taken to separate the inmates, whether young or old, innocent or guilty; and it is where this separation has been most strictly enforced, as with us, that crime has most appreciably diminished.

But the penal system, however carefully and intelligently worked, is but a small contributory cause to reduction. That is to be found rather in the newer and more enlightened processes of deferred sentences for first offenders and of systematic child rescue, both based upon the excellent principle that crime should be checked in the bud. Dr. Christison enunciates a truism when he declares that crime is frequently associated with bodily and brain disease. No one denies this; it is, too often the poor invertebrate creatures who have no sinew, moral or physical, who lapse into misdeeds, and they deserve pity rather than punishment. But these do not make up the sum total of the great army of crime; they do not include the stalwart, able-bodied habitual criminal—the real crux of modern penology—who has adopted law-breaking as a business, and whom nothing, humanely speaking, will cure. To apply Dr. Christison's kindly milk and water treatment to these would be a mischievous misuse of the power of the law, the first duty of which is to protect the law-abiding from the law-breaking. The habitual criminal should have neither truce nor peace. Penal science is fast tending to establish the somewhat paradoxical apothegm of a well-known writer who has said that offenders may be divided into two great classes: "those who should never go into prison and those who should never be let out"; the first offender who should be left at large on condition that he does not again go wrong, and the habitual criminal who is retained indefinitely, or until he gives reasonable promise that he will not persistently misuse his freedom.

OUR BOOK SHELF.

Chauncy Maples, D.D., F.R.G.S. A Sketch of his Life, with Selections from his Letters. By his Sister. Pp. 403. (London: Longmans, Green, and Co., 1897.)

THE publication of this memoir of Dr. Chauncy Maples—a pioneer missionary in East Central Africa for twenty years—reveals that sympathetic interest in science which has been strikingly noteworthy in some of the most remarkable missionaries of our time. In 1881 Mr. Maples, then stationed at Masasi, made a journey of 900 miles to the Meto country, and in this and other ways contributed to our knowledge of the geography of East Africa. His papers were appreciated by the Royal Geographical Society, of which he was a Fellow. And he quite entered into the spirit of the recent development of Nyasaland at the hands of the British administrators, founding and editing the *Nyasa News*, which was printed on the island of Likoma by his native boys. Sir Harry Johnston, K.C.M.G., contributed to it, and writes cordially of the late Bishop in his recent book on "British Central Africa." Sir Harry was almost the last European to see him alive; for a few days afterwards he was drowned in the Lake Nyasa, September 3, 1895, on his way to his post. In the Bishop's last letter but one, written, of course, before the knighthood, he says: "I was more struck than ever with the Commissioner's cleverness and accomplishments and his power of doing so many things, as he does, so very well. He is certainly a very remarkable man indeed."

On the other hand, Mr. G. F. Scott-Elliot, a scientific traveller well known to the readers of NATURE, looked upon Chauncy Maples as "an ideal missionary," and described him as "one whose sympathies extend even to Europeans." Several times in the letters now published reference is gratefully made to the geological works of Sir Archibald Geikie. In a private letter dated Likoma, March 14, 1888, Archdeacon Chauncy Maples has the following striking and sympathetic reference to Charles Darwin:—

"It would seem that part of his nature adapted to the reception and cultivation of religious truth got atrophied by disuse, and hence his discarding of Christianity. These things are great mysteries, and when we think of so great and really good a man as Darwin was, we ought to avoid all appearance even of seeming to know *how* he stood in God's sight when his probation was over and his soul returned to God who gave it. . . . Another great point about Darwin was that he never did or said anything that could be construed into a desire to disturb the faith of others; if evolution has disturbed it, it is their fault and not his. I confess to having a good deal of belief in evolution; but it has never disturbed my faith in revelation—no, not one jot" (p. 294).

The late Bishop was, like the friend and colleague who has succeeded him as Archdeaçon, the Rev. W. P. Johnson, a graduate of University College, Oxford. His successor, the present Bishop of Likoma, Dr. J. E. Hine, is also an Oxford man, having graduated in science both in Oxford and London. Of the latter University he is M.D. It is also remarkable that another South African Bishop had a distinguished scientific career, both at London and Cambridge. The Bishop of Bloemfontein, the Right Rev. J. W. Hicks, is Doctor both of Medicine and of Theology. He is M.D. Lond., D.D. and Sc.D. Camb., and late Fellow and Science Tutor of Sidney Sussex College, Cambridge. J. F. H.

Les Ballons-Sondes. Par M. de Fonvielle. (Paris: Librairie Gauthier-Villars, 1898.)

WITHIN the last seven years a new epoch has dawned upon the science of aerial travel and investigation.

While the more directly practical advances in flying machines and balloon navigation have caught the popular fancy, a less conspicuous but more valuable means of extending our present knowledge of atmospheric physics has been supplied by the recently organised flight of small, specially constructed balloons provided with self-recording apparatus which, without the deterring weight of observers, have been able to explore regions of the atmosphere far beyond the limits of human endurance.

M. de Fonvielle, the celebrated French aeronaut, has brought together the results so far attained in a neat little brochure entitled "Les Ballons-Sondes," or "sounding balloons." Perhaps "exploring balloons" would be a freer and more euphonious translation.

Here we have in four chapters a clear and simple

account of these experiments from the earliest attempts of MM. Hermite and Besançon, the chief pioneers of the movement, to the latest ascents under the auspices of the International Committee in November 1896.

Perhaps the most interesting and suggestive chapter is that which deals with the theory of the ascent of an exploring balloon.

The results of the recent simultaneous international flight of aerophile balloons are also very suggestive.

The possible limits attainable by balloons are shown to depend quite as much on the character of the envelope as on the contained gas. Here also, for the first time, we find a clear exposition of the effect of the temperature of the gas over that of the surrounding air, and the "Montgolfier" effect of solar radiation in altering the height at which the balloon finds itself in neutral equilibrium.

When it is found that winter and summer can cause a change of 6000 feet, and day and night one of 8000 feet in the altitude attainable on the pressure theory, it must be recognised that the science of exploring balloons is far from simple.

The scientific value of such ascents, reaching as they have done already in the case of the "Cirrus" to 60,000 feet, or double that hitherto attained by man (Mr. Berson's 30,000 feet in the "Phœnix," December 1894), is undoubted, and M. de Fonvielle deserves the thanks of the scientific world for his lucid and fascinating account of a scientific art which is even more necessary for the advance of terrestrial and cosmical physics than the soundings of our deep-sea exploring ships. D. A.

A Geological Map of the Southern Transvaal. By F. H. Hatch, Ph.D., F.G.S. (London: Edward Stanford, 1897.)

THIS map, on the scale of four miles to the inch, will be useful to prospectors and those interested in the general geology of the district. The names and boundaries of the farms are given, and the geological map is accompanied by a physical map of the Transvaal.

The geological formations are broadly sketched in; the Witwatersrand, Black Reef and Megaliesberg series are represented as forming a trough let in by faults between a mass of primary rocks. The sections across country show a simplicity of structure for the Witwatersrand district with some complications by faulting north of Parys. The Witwatersrand beds are considered to represent the Table Mountain Sandstone and the Megaliesberg or Gats Rand series to be equivalent to the Zwartebergen Sandstone group.

The extent to which the beds are interfered with by volcanic rocks can be seen from the map. Besides the interbedded flows of basalts and diabases, a large area west of Klerksdorp is represented as composed of rhyolitic and andesitic flows, and north of the Megaliesberg Range and north-east of Pretoria there is a wide tract coloured as gabbro. The igneous flows of Pre-Karoo age are confined in Cape Colony to formations older than the Table Mountain Sandstone, so that if the age of the Gats Rand beds is correctly determined, the southern Transvaal exhibits a volcanic phase unrepresented in the Cape.

Untersuchungen über das Erfrieren der Pflanzen. By Prof. Dr. Hans Molisch. Pp. viii + 73. (Jena: Fischer, 1897.)

IN "Untersuchungen über das Erfrieren der Pflanzen," Prof. Molisch recounts his experiments on the cooling and freezing of plants. Dr. Molisch has worked over much of the old ground, and his observations, in the main, confirm those of previous workers. A comparison of the results obtained by Dr. Molisch with those set forth in the admirable summary in Pfeffer's "Pflanzen Physiologie," will show that the volume under notice contains little that is absolutely new.

By means of an improved apparatus, Dr. Molisch has examined the effects of freezing and thawing on such substances as starch-paste, gelatine, albumin and protoplasm. His conclusions confirm and extend those of Vogel and Kühne. As in the above-mentioned organic substances so in the protoplasm, *e.g.* of an amœba, freezing induces a reticular structure whose meshes contain pure ice. In many instances, however, ice formation only occurs, as is well known, outside the cell. Attention may, in passing, be drawn to the statement (p. 19) that, "to some extent," the smallness of plant cells represents "a means of protection against cold": were it not for the fact that the remark is considered worthy of repetition, it might have been regarded as intentionally ironical. As it is, it must be inferred that Dr. Molisch wishes to be numbered with the ultra-adaptationists.

Sachs had inferred, from observations on the relative rates of mortality in plants slowly and quickly thawed, that it is not the frost but the thaw that kills. H. Müller-Thurgau has shown this not to be generally correct. Dr. Molisch confirms H. Müller-Thurgau.

The most interesting of Dr. Molisch's experiments are those which prove that the withering of plants exposed to cold, although accompanied by, is not due to a slowing of the transpiration-current.

The practice of embodying a research in a volume intended for the public and the specialist alike is, where the results are of high generality, excellent; where, however, as in this volume, the results appeal primarily, if not solely, to the physiologist, and where the net is spread wide by rendering the meshes diffuse, fellow workers are entitled to protest. The "literature" is already a heavy burden and grievous to digest.

Random Shots at Birds and Men. By "Jim Crow." Pp. 117. (Westminster: The Roxburghe Press.)

THIS paper-covered booklet needs no extended notice from us. It is made up of very fugitive thoughts on birds, and moralisings on the ways of men, and is not, we should think, likely to interest either the student of science or the general reader.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Some Errata in Maxwell's Paper "On Faraday's Lines of Force."

IN translating this paper of Maxwell for Ostwald's "Klassiker der exacten Wissenschaften," I have detected some errors, which are partly merely misprints, but partly also faults in the formulæ of some trouble to the reader. The German translation is only of value to those who have not leisure to study the English language before the works of Maxwell; but the accuracy of such classic works is so essential to every one, that I considered the publication of the errata found to be of even greater importance than my whole translation. But in order to make the translation as cheap as possible, the German editor refused to print my list of errata, and I therefore hope it will be printed in England.

Finally, if Maxwell and the editor of his works have not avoided some troublesome errors, I do not wish to apply the *quod Jovi licet, non bovi licet*, to Mr. Curry's new book, "Theory of Electricity and Magnetism" (Macmillan, 1897), but to excuse some errors therein.

In the following table the first column gives the place of the misprint in the *Cambridge Philosophical Transactions*, vol. x. 1856; the second in Maxwell's "Scientific Papers," vol. i.

Cambridge Transactions	Scientific Papers	Read	Instead of
p. 38, l. 21 f. a.	p. 170, l. 16, f. a.	external medium	internal medium
p. 39, l. 3 f. b.	corrected	$S_1\beta + (m\alpha - l\beta)T$	$S_1\beta - (m\alpha - l\beta)T$
p. 40, l. 6 f. a.	,,	$\beta = \frac{dp}{dy},\ \gamma = \frac{dp}{dz}$	$y = \frac{dp}{dy},\ z = \frac{dp}{dz}$
p. 42, l. 1 f. b.	,,	$X = -\frac{dp}{dx}$	$X = -\frac{pd}{dx}$
p. 54, l. 12 f. b.	p. 192, l. 2 f. a.	$-4\pi\rho$	$+4\pi\rho$
,, ,, 11 ,,	,, ,, 3 ,,	$-\int e dS$	$+\int e dS$
p. 56, l. 16 f. a.	corrected	$\beta_1 + \frac{d\beta_1}{dz}\frac{dz}{2}$	$B_1 + \frac{d\beta_1}{dz}\frac{dz}{2}$
,, ,, 2 f. b.	p. 195, l. 2 & 3 f. a.	$\alpha_1, \beta_1, \gamma_1$	$\alpha\beta\gamma$
p. 58, l. 10 f. b.	corrected	$\frac{1}{k}$	k
p. 59, l. 5 f. b.	p. 198, l. 4 f. b.	$\int\frac{da}{dz}dz$	$\int\frac{da}{dy}dz$
p. 62, l. 2 f. a.	p. 201, l. 13 f. a.	$4\pi\rho_1 + (a_0a_2 + b_0b_2 + c_0c_2)$	$4\pi\rho_1 - (a_0a_2 + b_0b_2 + c_0c_2)$
,, ,, 14 f. b.	p. 202, l. 5 ,,	$-\alpha_0\left(\frac{d\beta_1}{dz} - \frac{d\gamma_1}{dy}\right) - \beta_0\left(\frac{d\gamma_1}{dx} - \frac{d\alpha_1}{dz}\right) - \gamma_0\left(\frac{d\alpha_1}{dy} - \frac{d\beta_1}{dx}\right)$	$+\alpha_0\left(\frac{d\beta_1}{dz} - \frac{d\gamma_1}{dy}\right) + \beta_0\left(\frac{d\gamma_1}{dx} - \frac{d\alpha_1}{dz}\right) + \gamma_0\left(\frac{d\alpha_1}{dy} - \frac{d\beta_1}{dx}\right)$
,, ,, 13 ,,	,, ,, 7 ,,	$\rho_1')\ +$	$\rho')\ -$
,, ,, 11 ,,	,, ,, 9 & 11 f. a.	ρ'_1 and ρ_1	ρ' and ρ
,, ,, 9 ,,	corrected	$+(\alpha_0a_2 + \beta_0b_2 + \gamma_0c_2)$	$-(\alpha_0a_2 + \beta_0b_2 = \gamma_0c_2)$
p. 63, l. 9 f. b.	p. 203, l. 11 f. b.	$p_1\rho_1\ +$	$p_1\rho_1\ -$
p. 64, l. 13 f. a.	p. 204, l. 15 f. a.	$dxdydz = 0$	$dxdydz$
,, ,, 15 ,,	,, ,, 18 ,,	$+\frac{1}{4\pi}\frac{d}{dt}\left(a_2\alpha_0 + b_2\beta_0 + c_2\gamma_0\right) = 0$	$= \frac{1}{4\pi}\frac{d}{dt}\left(a_2\alpha_0 + b_2\beta_0 = c_2\gamma_0\right)$
,, ,, 3 f. b.	corrected	particle	article
p. 69, l. 9 f. b.	p. 211, l. 10 f. b.	b_1	b
,, ,, 1 ,,	corrected	$\frac{a}{R}$	$\frac{a}{R}$
p. 70, l. 12 ,,	p. 212, l. 4 f. b.	$l\frac{d}{dx}\left(\frac{m}{r}\right)$	$\frac{d}{dx}\left(\frac{m}{r}\right)$
p. 71, l. 3 ,,	corrected	α, β, γ	$\alpha_1, \beta_1, \gamma_1$
p. 72, l. 11 f. a.	p. 214, l. 4 f. b.	x	X
,, ,, 12 ,,	corrected	α	α_1
,, ,, 12 ,,	p. 214, l. 2 f. b.	$-\alpha + \frac{d\alpha}{dz}\frac{l_3}{2}$	$-\alpha + \frac{d\alpha}{dz}\frac{l_2}{2}$
p. 73, l. 14 ,,	p. 216, l. 6 f. a.	$+2\frac{k - k^1}{2k + k^1}\frac{a^3}{r^3}\left(1 - 3\cos^2\theta\right)$	$+\frac{k - k^1}{2k + k^1}\frac{a^3}{r^3}\left(1 - 3\cos^2\theta\right)$
,, ,, 18 ,,	,, ,, 11 ,,	$\left(2 - \frac{k - k^1}{2k + k^1}\frac{a_3}{b_3}\right)$	$\left(1 - \frac{k - k^1}{2k - k^1}\frac{a^3}{b^3}\right)$
p. 75, l. 4 f. a.	p. 218, l. 12 ,,	y and z	x and y
p. 76, l. 10 f. b.	p. 220, l. 13 ,,	k is Aa^3	$k = Aa^3$
,, ,, 8 ,,	,, ,, 14 ,,	$p' = -\left(I + A\right)\frac{a^3}{r^2}\cos\theta$	$p' = \left(I + A\right)\frac{a^3}{r^2}\cos\theta$
,, ,, 8 ,,	,, ,, 14 ,,	$p_1 = -(I + A)r\cos\theta$	$p_1 = (I + A)r\cos\theta$
,, ,, 5 ,,	corrected	$\frac{2}{k^1}\left(I + A\right)$	$\frac{2}{k}\left(I + A\right)$
p. 77, l. 15 f. a.	p. 221, l. 10 f. a.	at $d\theta$	$td\theta$
,, ,, 17 ,,	,, ,, 12 ,,	$\frac{3I}{t}\sin\theta$	$-3I\frac{a}{t}\sin\theta$
p. 78, l. 12 f. b.	corrected	$\frac{d\beta_0}{dz}$	$\frac{d\beta_0}{dr}$
,, ,, 10 ,,	p. 223, l. 8 f. a.	$\frac{1}{2k + k^1}$	$\frac{1}{3k + k^1}$
,, ,, 7 ,,	,, ,, 11 ,,		
p. 79, l. 6 f. a.	,, ,, 2 f. b.		
,, ,, 14 ,,	p. 224, l. 8 f. a.		
,, ,, 6 ,,	p. 223, l. 2 f. b.	I_2	I
,, ,, 3 ,,	corrected	n'	n

Cambridge Transactions	Scientific Papers	Read	Instead of
p. 79, l. 6 f. b.	p. 224, l. 6 f. b.	$\frac{\mathrm{N}n'^2}{\mathrm{RR}'}\frac{d\mathrm{F}}{dt}$	$\mathrm{N}\frac{n'^2}{\mathrm{R}'}\frac{d\mathrm{F}}{dt}$
p. 81, l. 11 ,,	p. 226, l. 1 ,,	$\nabla^2 p_2$	$\nabla^2 p$
,, ,, 2 ,,	corrected	$-\frac{1}{4\pi}\frac{\mathrm{I}}{2}\cos\theta\omega y$	$\frac{1}{4\pi}\frac{\mathrm{I}}{2}\cos\theta\omega y$
p. 82, l. 4 f. a.	,, ,,	$k\left(\frac{da_2}{dy}-\frac{db_2}{dx}\right)$	$k\left(\frac{du_2}{dy}-\frac{dv_2}{dx}\right)$
,, ,, 9 ,,	,, ,,	$p_2=\frac{\mathrm{I}\omega}{16\pi}\left[-\left(x^2+y^2\right)\cos\theta+xz\sin\theta\right]$	$p_2=\frac{\mathrm{I}\omega}{16\pi}\left[\left(x^2+y^2\right)\cos\theta-xz\sin\theta\right]$
,, ,, 14 ,,	p. 228, l. 6 f. a.	$\frac{\mathrm{TR}^4}{48\pi k}\omega\mathrm{I}\sin\theta$	$\frac{\mathrm{TR}^3}{48\pi k}\omega\mathrm{I}\sin\theta$
,, ,, 9 ,,	,, ,, 14 f. b.		
,, ,, 7 ,,	,, ,, 12 ,,	I	I_1
,, ,, 3 ,,	,, ,, 7 ,,		
p. 83, l. 3 ,,	,, ,, 2 ,,		
p. 82, l. 3 f. b.	,, ,, 7 ,,		
,, ,, 2 ,,	,, ,, 6 ,,		
p. 83, l. 3 f. a.	,, ,, 2 ,,	TR	T
,, ,, 4 ,,	,, ,, 1 ,,		
,, ,, 12 ,,	p. 229, 8 f. a.		
,, ,, 6 ,,	,, ,, 1 ,,	$\operatorname{cotg}\phi=-\frac{\mathrm{TR}\omega}{24\pi k}$	$\operatorname{cotg}\phi=-\frac{\mathrm{TR}^3\omega}{24\pi k}$
,, ,, 6 ,,	,, ,, 1 ,,	$\mathrm{I}'=\frac{1}{2}\frac{\frac{\mathrm{TR}\omega}{24\pi k}}{\sqrt{1+\left(\frac{\mathrm{TR}\omega}{24\pi k}\right)^2}}\mathrm{I}\sin\theta$	$\mathrm{I}'=\frac{1}{2}\frac{\frac{\mathrm{T}}{24\pi k}\omega}{\left(\sqrt{1+\frac{\mathrm{T}}{24\pi k}\omega}\right)^2}\mathrm{I}_1\sin\theta$
,, ,, 7 f. b.	,, ,, 9 f. b.	$\frac{1}{2}\frac{\mathrm{T}\omega\mathrm{R}^4\mathrm{I}\cos\theta}{\sqrt{(24\pi k)^2+\mathrm{T}^2\mathrm{R}^2\omega^2}}$	$\frac{1}{2}\frac{\mathrm{T}\omega\mathrm{R}^3\mathrm{I}\cos\theta}{\sqrt{(24\pi k)^2+\mathrm{T}^2u^2}}$
,, ,, 5 ,,	,, ,, 6 ,,	$\frac{12\pi k\mathrm{T}\omega\mathrm{R}^4\mathrm{I}^2\cos^2\theta}{(24\pi k)^2+\mathrm{T}^2\mathrm{R}^2\omega^2}$	$\frac{12\pi k\mathrm{T}\omega\mathrm{R}^3\mathrm{I}^2\cos^2\theta}{(24\omega k)^2+\mathrm{T}^2\omega^2}$
,, ,, 3 ,,	,, ,, 4 ,,	$\frac{12\pi k\mathrm{T}\omega^2\mathrm{R}^4\mathrm{I}^2\cos^2\theta}{(24\pi k)^2+\mathrm{T}^2\mathrm{R}^2\omega^2}$	$\frac{12\pi k\mathrm{T}\omega^2\mathrm{R}^3\mathrm{I}^2\cos^2\theta}{24\pi k+\mathrm{T}^2\omega^2}$

Vienna, October 25. LUDWIG BOLTZMANN.

The Late Dr. Haughton.

IN your account of the late Dr. Haughton, as well as in those written of him elsewhere, I see no mention of a somewhat fantastic instance of his versatility—namely, his investigation into the most merciful way of hanging criminals. It was, I believe, entirely owing to him that the present method of the "long drop" was introduced. According to the older method the rope was so arranged that the culprit fell barely knee deep, all the rest of his body being in view above the scaffold. He died usually by strangulation, sometimes combined with apoplexy, after what seemed to be a protracted agony Now, he is allowed to fall through some 10 feet, more or less, according to his estimated bulk and weight, and he dies with a broken neck more painlessly than virtuous persons in their own beds. The problem was to find out the length of drop that would suffice to break the neck bone, but would be insufficient to tear off the head. Dr. Haughton experimented on the tensile strengths of the spine and of the muscles, and he published a formula for the length of drop, dependent on the height and weight of the culprit. In this, I thought he had omitted a small factor, and wrote to him about it—namely, the increased sectional area the muscles of the neck in fat men. It should be mentioned that a case actually occurred in which the drop was too deep, and the head of the criminal became wholly detached, and the legal doubt arose whether under those circumstances the sentence of being "hanged by the neck" had been duly carried out. I regret much that I have to write wholly from memory now, which I trust has not deceived me. It is very possible that Dr. Haughton's formula may be found in one of the earlier numbers of NATURE. F. G.

The Supposed Dowsing Faculty.

PERMIT me to guard your readers against a misapprehension likely to be caused by the review in NATURE of October 14, of an investigation I have recently published on the alleged existence of a faculty for finding underground water, a power claimed by certain persons called "diviners" or "dowsers."

The reviewer states twice over that the "bulk of the paper is taken up with hearsay evidence," and again that it is "an accumulation of second-hand evidence," and that I do not give "enough weight to the natural tendency of mankind to conceal their failures." If these statements could be justified I should agree with your reviewer that my investigation "leaves the subject in the same state as it found it." But the peculiar meaning your reviewer attaches to the words he employs, and hence the value of his opinion, may be inferred from the following facts:—

Six years ago I was asked by the Council of the Society for Psychical Research to examine this question. I had, therefore, in addition to experiments which I myself conducted, to take the place of a judge in a court of inquiry, and give weight to no evidence but that of *eye-witnesses;* and so, in almost every one of the 152 numbered cases *pro* and *con* that are given in my paper, I quote such written and signed evidence, independent of the dowser himself. These witnesses are mostly men of good position, or wide experience, and to whom the question of obtaining water was a matter of practical importance and pecuniary outlay. The argument that some of them were biassed is a perfectly fair criticism, if true, but the bias was usually more on the side of incredulity than of credulity; take, *e.g.* the extreme scepticism of Mr. Richardson, the employer in the remarkable Waterford case, and of Sir Henry Harben in that at Warnham.[1] No evidential value is

[1] It may well be urged that a man would not employ a dowser unless he were already biassed in his favour. But the gentlemen named above, and several other witnesses I have cited, consented to this course, either to gratify their friends, or as a *dernier ressort*, only after scientific advice and large expenditure on boring had failed to find the water supply they needed. Their attitude towards the dowser when he arrived was that of ill-disguised contempt. How far "lucky hits" or "mother wit" can explain the dowser's success in these and other cases, the reader of my paper must judge for himself.

attached in my paper to any case not fully corroborated, and out of scores of such cases received some half-dozen have been published, as is expressly stated in my paper, in order to elicit further information on account of their intrinsic interest.

As regards the liability to overlook failures, I have referred to this point both at the outset of my paper (p. 4) and elsewhere; further (on pp. 238 and 239), I state: "It must be borne in mind that (especially among amateur dowsers) one is more likely to hear of success than failure, and therefore an extensive and searching inquiry is necessary before any safe induction can be drawn. . . . All that was possible in the present investigation was to make the range of evidence as wide and unbiassed as possible, and not exclude a single case of failure that was substantiated. This has been done." It is, of course, easy to select, as your reviewer does, a certain number of cases in which the failures exceed the successes.[1] But I think one is more likely to arrive at a correct estimate by the method I adopted, which was to make extensive inquiries, both generally and specifically, with regard to failures as well as successes in the case of every professional dowser I heard of. This is naturally a vastly more laborious method than your reviewer's, but was necessary in order to arrive at the actual facts in a subject which from all sides has been loosely discussed, albeit by eminent men, for upwards of 200 years.

I am glad to find your reviewer endorses certain cautions I suggested in the event of further investigation; though what he means by "thought-reading" as a source of error is not quite clear. It is a matter of importance, more so than your reviewer appears to imagine, to recognise, and if possible exclude, the aid which the dowser derives from indications given by the surface of the ground. Long practice may give the most illiterate person a power of detecting surface indications of underground water, or the faint tremor of unseen running water, that would entirely escape the ordinary observer, and of enabling correct inferences to be drawn even from indications that the dowser may have noticed quite unconsciously. We have here, doubtless, the explanation of some of the singular successes of dowsers in finding water; but a careful examination of the evidence I have collected has led me to think that no explanation hitherto suggested is adequate to account for all the facts.[2]

Kingstown, Co. Dublin, October 21. W. F. BARRETT.

AT the head of Prof. Barrett's memoir is the following quotation from Mr. Andrew Lang: "There are two ways of investigating the facts or fancies about the divining rod. One is to examine it in its actual operation—a task of considerable labour, which will doubtless be undertaken by the Society for Psychical Research; the other, and easier way, is to study the appearances of the divining wand in history." This naturally led me to think that Prof. Barrett intended to treat the subject as, in the main, a matter for personal investigation. He now claims, however, "to take the place of a judge in a court of inquiry." I therefore withdraw the term "hearsay" applied to the bulk of the evidence he has so laboriously collected, and will accept his own view of his position.

But Prof. Barrett will agree with me that this is a technical investigation needing expert knowledge. Now if so, where does the necessity for expert knowledge come in? Surely not after the experiments have all been made, and the dowser is off the scene; but, as in any other scientific investigation, on the spot, with the man and the conditions all before you. This is the very core of the investigation, and no amount of after analysis can atone for the lack of *personal* observation and judgment exercised at this, the crucial point. But here, where expert knowledge and observation are essential, he relies on others, of whom the majority have no previous knowledge or scientific training whatever.

Prof. Barrett "had to exclude all evidence but that of *eye-witnesses*." As to his "152 numbered cases," 9 are avowedly supplied by people who, on their own statement, do *not* appear to be eye-witnesses. In 41 more there is nothing to show whether his informant met the dowser himself, or is trusting to information received from others. The information in 8 of these comes from a firm or joint-stock company; 8 are merely newspaper reports; some are ancient cases, which cannot now be inquired into.

With reference to the statement regarding liability to overlook failures, I did not state or wish to imply that Prof. Barrett had not fairly given all the failures which came to his knowledge. What I did wish to imply was, that his method of writing to the parties concerned for evidence on this point was not likely to yield much result.

As to the Isle of Wight, I may say, that not making it a habit to collect information regarding the employment of dowsers in different districts, I merely alluded to one where I happened to have stumbled upon facts bearing on the question. Whether or no other districts would give similar or contrary results I cannot say, having no material to go upon.

I fail to understand what meaning Prof. Barrett attaches to the term "surface indications." He agrees with me as to their great importance; yet there are only 32 cases in which his informants make even the slightest reference to this subject, and in only 8 is there any note that Prof. Barrett made special inquiries on this all-important point.

As previously stated, my criticisms apply to the bulk of the evidence. I thoroughly recognise the value of Prof. Barrett's personal observations, and have only to regret that these experiments form so very small a part of his memoir.

THE WRITER OF THE ARTICLE.

[1] The reviewer is, however, delightfully free from the pedantry of those who think accuracy desirable when dealing with such a contemptible superstition as the so-called divining-rod. This, I think, is apparent already; it becomes more so when specific assertions of his are examined, such *e.g.* as "only two successes are mentioned in the Isle of Wight," &c.

[2] That a mixture of crass ignorance and charlatanry is to be found in many professional dowsers, and that some of them are little better than rogues, is only what might be expected; but, on the other hand, we have the fact that so distinguished a *savant* as M. Mortillet was once, as he tells us himself, a professional dowser, and published a book on water-finding in 1849. The President of the Royal Geological Society of Cornwall is still a successful amateur dowser.

A Proposed Memorial to Prof. Victor Meyer.

THERE appears to be a strong desire among many of the British students who worked under the late Prof. Victor Meyer, to give expression to the feelings of gratitude and admiration with which they remember him, by raising some form of memorial to be placed in the Heidelberg Lecture Theatre.

It has therefore been decided to call a general meeting of Prof. Meyer's British students, to be held in Manchester on Saturday, December 11, at 5 p.m. Prof. H. B. Dixon, F.R.S., has kindly placed the Organic Lecture Theatre of Owens College at our disposal.

All past students of the late Victor Meyer, whether they worked with him in Zürich, Göttingen or Heidelberg, are earnestly requested to be present.

I shall be pleased to receive suggestions from any who may be unable to attend, in order that they may be laid before the meeting. J. J. SUDBOROUGH.

University College, Nottingham, November 23.

The Critical Temperature of Water.

CAN any of your readers tell me what is the critical temperature of water. I find in the supplement to Jamin and Bouty's "Cours de Physique" the critical temperature given as 370° C. and the corresponding pressure as 195·5 atmospheres. On the other hand, Cagniard-Latour gave this temperature as equal to the melting point of zinc, which is known to be about 415° C.

I have some theoretical grounds for believing this latter figure to be the more accurate, so should be glad to know what other determinations, if any, have been made. H. M. MARTIN.

39 Guildford Street, W.C., November 19.

Coccoliths in our Coastal Waters.

IN our communication to NATURE, September 16, 1897, we say "the presence of these bodies (coccoliths) in our coastal waters does not appear to have been recorded." Since this was written we find that Dr. Wallich, in the *Ann. and Mag. of Natural Hist.*, vol. ii. 1868. p. 319, stated "Coccospheres have been met with by me profusely . . . in material collected at the surface of the open seas of the tropics, and also in dredgings from shoal water off the south coast of England"

November 18. J. JOLY.
HENRY H. DIXON.

Phenomena Exhibited by Jackson Tubes.

WHILE investigating the best methods of working the ordinary form of Jackson tubes during the last fourteen months, I have noted the following interesting phenomena.

Four tubes developed a phosphorescent ring or halo rotating rapidly round the anode, which by carefully heating became comparatively steady; this I ventured to name the Saturn condition.

Four tubes developed in bulb broad bands of light yellow-green electrical molecules, interspaced with darker bands; this was like the marking of the planet Jupiter.

Two tubes developed a mottled and leaf-patterned electric-molecular condition, extremely like the appearance of the photosphere of the sun (for the first time the skin of my hand was affected by one of these tubes—November 1896; this hand having some years previously had gouty eczema; the other hand was not affected in either case).

Two tubes developed forms like the clouds known as "mares'-tails"; one tube, a form like the sulky lower strata of distant thunder-clouds.

The most interesting phenomenon was one which was also seen by a medical friend: the whole tube was a mass of yellow-green phosphorescence, even behind the kathode; the molecular film in glass bulb in front and round the edge of the kathode (mottled condition) developed a small black spot the size of a pin-head, which increased to the dimensions of a small pea, broadened out into an irregular patch, split up into small spots, which ran round the bulb, disappeared; reformed into a patch—diminished—and disappeared. The phenomenon was repeated at regular intervals for ten minutes, then finally stopped. The irregular patch was extremely like a sun-spot.

From time to time I have called the attention of interested friends to the above phenomena, so as to have witnesses, as the tubes seldom repeat the same conditions, which can only be attained by the application of heat while working the tube.

The rays magnetised my watch on two occasions; an induction coil having no magnetic field, owing to interrupted current, could not do this.

WILLIAM WEBSTER.

Art Club, Blackheath.

REMARKABLE TERMITE MOUNDS OF AUSTRALIA.

THE destructive propensities and architectural endowments of the termites or white ants are familiar subjects to most travellers and residents in tropical countries. Notwithstanding, however, the almost cosmopolitan distribution within tropic areas of these insect pests, an astonishingly small amount of accurate data has been chronicled concerning their specific varieties or the widely varying modifications of their social tenements.

As a matter of fact the figures and descriptions of the insects and nest mounds or "termitaria" of the African white ants *Termes bellicosus*, *T. mordax*, and other species contributed by Henry Smeathman to the *Transactions* of the Royal Society for the year 1781, constitute up to the present date the standard account of white ants and their ways that is reproduced with trivial variations in most modern zoological text-books. Much, undoubtedly, has been accomplished within recent years, notably through the investigations of Grassi and Sandias, Fitz Müller, and other biologists to elucidate the minute anatomy, individual modifications, and social economy and relationships of the indigenous or imported South European types *Termes incifugus* and *T. flavipes.* Neither of these forms, however, are mound constructors, but live within subterranean tunnels or in excavations of the wood which they devour. Smeathman is hence still left, *facile princeps*, the first, almost the only authority on the architectural fabrications of the mound-constructing species.

While Africa in connection with Smeathman's investigations has hitherto inherited an undisputed monopoly in the matter of termite mounds, it will probably be found that the island continent of Australia can produce an equally, and in some respects even more noteworthy variety of these insect edifices. So far as altitude is concerned, the palm among the Australian series must be conceded to the huge buttressed columnar termitaria that occur some forty miles inland from Port Darwin in the Northern Territory of South Australia. A height of at least eighteen feet is not unfrequently attained by this variety, and their diameter being almost equal throughout, their appearance has been appropriately likened to miniature towers. Termitaria almost equal in altitude to this Port Darwin variety have also been observed by the writer in York Peninsula, North Queensland, and are notably abundant on the point of land abutting upon the mainland foreshore of the southern entrance to the Albany Pass. The largest termitaria of this type occur, however, in the vicinity of the bridle path between Mr. Frank Jardine's homestead at Somerset, and the former telegraph station at Patterson facing Endeavour Strait. Passing them on horseback, many of these mounds were observed to tower considerably above the rider's head. The contour of these York Peninsula termitaria differs essentially from that of the Port Darwin form. In place of being subcylindrical or columnar, they are distinctly pyramidal, widest at the base, and tapering up to a single, or it may be occasionally several accuminate points.

Within the tropical area of Western Australia, known as the Kimberley district of that colony, a third large and very distinct type of termitarium is dominant. While most commonly presenting a symmetrically conical or hemispherical contour, it not unfrequently happens that these white ant mounds are built up into the most irregular and fantastic shapes. Throughout all such innumerable modifications, however, one essentially unique fundamental plan of structure is predominant. This is exemplified by the circumstance that each nest mound or termitarium presents the appearance of having been built up, as it were, by the superposition of consecutive hod-loads of half solidified mortar, and which before setting has partly overflown and overlapped the preceding instalments.

This lobulated or Kimberley type of termite mound, as it may be designated, occurs in great abundance and in its finest development in the thinly wooded scrub or so-called "pindan" in the neighbourhood of Derby, at the head of King's Sound. One of the tallest of these termitaria was found to measure as much as fourteen feet, but this altitude is occasionally exceeded. The separate occasions on which the writer visited King's Sound were utilised by him for obtaining information concerning the approximate time that is occupied by the termites in the reconstruction of a partially dismantled edifice. Examples of termitaria about eight feet high were bisected vertically, the one half being completely demolished. Within twelve months one quarter of the denuded area had been filled in. Visited eighteen months later, fully two-thirds of the demolished moiety had been rebuilt, and it would evidently have not taken more than another twelve-months, or a total of between three or four years, to restore the mound to its original symmetrical shape and dimensions.

The most remarkable, though by no means the most lofty of the termite edifices peculiar to Australia, are those modifications of these structures which are popularly known by the local titles of "meridian," "magnetic," or "compass" ants' nests. The termitaria belonging to this category are distinguished by their elongate, much compressed contour, comparable in the most evenly constructed examples to huge slabs of undressed sandstone set up on edge. The upper edge or ridge of the "Meridian" termitarium is always the narrower, and is either nearly smooth, irregularly serrated, or may be developed into a series of slender pinnacles. The most notable feature respecting these white ant mounds is, however, the circumstance that the orientation of their longer axis is always coincident with the local parallel of latitude, or, in other words, in a precise line with the north and south points of the magnetic compass.

The most striking examples of these meridian ants' nests observed by the writer occur in the Laura Valley, North Queensland, some sixty miles from Cooktown. The altitude of these Laura Valley ant mounds is not very considerable, rarely, indeed, exceeding six or eight

feet. In accord with the peat-like alluvium out of which they are excavated and constructed, their colour is a dark ashen grey or nearly black. A distinctive feature of these meridian ants' nests is their highly ornate architectural style. They consist of a congeries of slender pinnacles erected close to one another in the same straight line, and which are finally amalgamated. Upon these primary pinnacles numerous subsidiary ones are usually constructed. The completed edifice, with its full complement of spires and pinnacles, comes thus when viewed end on, as shown in certain of the photographs taken, to present in miniature a by no means remote resemblance to the architectural pile of some grand cathedral.

A second and simpler form of meridian ants' nest is especially abundant a few miles inland from Port Darwin. It differs from the preceding type in its more massive and less ornate structural plan. The upper edge is nearly smooth or irregularly serrated, but not produced into a series of slender pinnacles. It is further noteworthy, that the environments pertaining to these two meridian varieties differ materially. With the Port Darwin type the habitat affected is that of open grassy plains, while in the Laura Valley form the nest mounds are most abundantly constructed in typical, though thinly wooded forest land.

The *raison d'être* of the north and south directions of the longer axial planes, so eminently characteristic of the so-called "Meridian" ants' nests, has given rise to much speculation and a variety of interpretations. By some it is supposed to bear a direct relationship to the prevailing winds. As, however, those in the districts where these ant-hills occur are chiefly south-east or north-west, according to the seasonal monsoon, that interpretation cannot be accepted as satisfactory. To the writer's mind a more probable explanation would appear to present itself in connection with the circumstance that being constructed in this precise meridian line, their larger surface presents the least possibly prolonged exposure to the meridianal rays of the tropical sun, and that the structures are consequently so built that they shall absorb and retain a minimum amount of solar heat. This question is, however, an interesting one that undoubtedly invites further scientific investigation. The subject of Australian termitaria constitutes, it may be noted, a copiously illustrated chapter in the writer's recently published work, "The Naturalist in Australia."

W. SAVILLE-KENT.

THE LIQUEFACTION OF FLUORINE.

FLUORINE was prepared for the first time in 1886 by Prof. Moissan, as a product of the electrolysis of anhydrous hydrogen fluoride contained in a platinum apparatus provided with fluorspar stoppers; the new gas was at once found to be the most active chemical substance known, many elements and organic compounds, such as arsenic, antimony, sulphur, iodine, alcohol, and turpentine, immediately and spontaneously bursting into flame when plunged into an atmosphere of fluorine. On mixing the gas with hydrogen, even in the dark, a violent detonation immediately occurs, hydrogen fluoride being produced. The violent action of fluorine upon nearly all substances with which it is brought into contact, obviously renders extremely difficult all experimental work involving the use of the free element. The great manipulative difficulties necessarily arising whilst dealing with the gas on the large scale have, however, been very happily surmounted by Prof. Moissan and Prof. Dewar, who recently described to the Chemical Society the method by which they have succeeded in liquefying fluorine, and determining the more important properties of the liquid substance (*Proc. Chem. Soc.*, November 4, 1897, p. 175). It seemed likely that the great chemical activity of fluorine might so far decrease at low temperatures as to allow of the manipulation of the material in a glass vessel cooled in liquid air; this was found to be the case.

The fluorine required in the work was prepared by the electrolysis of anhydrous hydrogen fluoride; this liquid being a non-conductor, was made a conductor by dissolving in it potassium fluoride. The liberated fluorine was freed from hydrogen fluoride by being passed first through a platinum worm immersed in a cooling mixture of solid carbon dioxide and alcohol, and subsequently through platinum tubes containing dry sodium fluoride. The purified gas was then passed down a vertical platinum tube fused to the neck of a thin glass bulb which served as the collector, and an exit was provided through a narrower platinum tube contained inside the first. On cooling the apparatus down to $-183°$ in boiling oxygen whilst the fluorine is passing through, no liquefaction occurs, but on reducing the pressure under which the oxygen is boiling, and so lowering the temperature to $-185°$, the fluorine condenses in the glass bulb to a very mobile yellow liquid; on removing the bulb from the cooling bath the liquid fluorine boils vigorously. Other experiments made with boiling liquid oxygen and liquid air as refrigerating agents indicated that fluorine boils at about $-187°$, namely at the boiling point of liquid argon; from this the probable critical temperature and pressure of fluorine are deduced as $-120°$ and 40 atmospheres respectively.

At these low temperatures fluorine is without action on glass, and does not displace iodine from iodides; silicon, boron, carbon, sulphur, phosphorus and reduced iron, all of which spontaneously ignite when brought into contact with fluorine at ordinary temperatures, do not inflame if, after being cooled in liquid oxygen, they are plunged into an atmosphere of fluorine. Hydrogen gas inflames spontaneously, with considerable evolution of light and heat, when directed on to the surface of liquid fluorine at $-190°$; on passing fluorine on to solidified turpentine cooled by boiling liquid air, a series of explosions occurred resulting in the destruction of the apparatus. It thus seems that the great affinity existing between hydrogen and fluorine is not overcome at $-190°$. A little liquid fluorine falling on the floor instantly inflames the wood. Fluorine is soluble in liquid oxygen, and on passing in the gas a white flocculent precipitate is formed which, after filtering off, deflagrates violently as the temperature rises; it is possibly a hydrate of fluorine.

Determinations made by floating pieces of various substances in liquid fluorine indicate that its density is about 1·14, and from the invisibility of amber immersed in the liquid the refractive index of the latter would seem to be higher than that of liquid air or oxygen. Liquid fluorine shows no magnetic phenomena when placed between the poles of a powerful electromagnet; it has a smaller capillarity constant than liquid oxygen, and does not solidify at $-210°$. It has no absorption spectrum, and its colour is the same as that of the gaseous element.

W. J. P.

THE LEONID DISPLAY, 1897.

VERY unfavourable weather appears to have prevented the successful observation of the Leonids at their recent return. In consequence of this the impression seems to have gained ground that the phenomenon did not occur as predicted. This is, however, a mistake. Could those observers who saw so little on the night of the 13th, have viewed the sky late on the following night, they must have been satisfied at the character of the display. Between about 4.30 and 6 a.m. on Monday morning the 15th, the usual streak-leaving meteors from Leo became very numerous, and some of them were unusually brilliant, one, which

appeared at 5.25 a.m., being brighter than the moon. Unfortunately the sky was overcast at the great majority of places at the time when the maximum occurred, and very few reports have come to hand, but they furnish unquestionable evidence as to a plentiful fall of meteors in the few hours preceding sunrise on the 15th.

Before midnight on the 13th, and during the early morning hours of the 14th, meteors were comparatively rare, and may be said to have been more conspicuous by their absence than by their presence. The shower of Leonids was of an extremely meagre character, and such as might occur in an ordinary year with the parent comet near its aphelion. But, apart from the disappointing meteors, the night of the 13th was one of singular beauty. At Bristol the sky partly cleared at 11.30 p.m., and the atmosphere became remarkably transparent. The moon and stars shone very brightly, and films of white cloud, floating rapidly across the sky, gave it a very picturesque appearance.

From the observations reported it may be well to make a few extracts :—

Mr. S. H. R. Salmon, South Croydon.—Sky perfectly clear November 13, 14h. to 16h. About seven meteors seen, including four bright ones as under :

h.	m.	s.	
15	3	45	First mag. from Andromeda.
15	28	0	First mag. Leonid.
15	32	45	First mag. Not a Leonid.
15	53	0	= Sirius. Probably a Leonid. It fell in a curved path slightly south of Jupiter, and was a beautiful object.

Rev. S. J. Johnson, Bridport.—Tolerably clear on November 13, between 15h. and 15h. 30m., but not a single meteor was observed.

Miss Brown, Cirencester.—The sky was perfectly clear on November 13, 11h. 45m. to 13h. 15m., and the eastern sky was watched from a window facing that quarter, but no meteors were seen.

Mr. W. H. Milligan, Belfast.—Cloudy weather prevented observation except on one night, November 13, 11h. to 12h. 30m., when only one sporadic meteor was recorded ; no Leonids.

D. W. Walton, Kingston-on-Thames.—Sky clear and moon bright on November 13, 10h. 30m. to 11h. 30m., but only one meteor appeared. Partly overcast afterwards, but a few faint meteors were noticed in breaks between the clouds.

Bristol.—The writer watched the sky on November 13, between about 11h. 30m. and 13h., but no Leonids were recorded. The sky clouded after 14h., and the following night was overcast throughout. Mr. Corder, at Bridgwater, reports that the nights following November 13 and 14 were too cloudy to permit of observation.

W. Trueman Tucker, Loughborough.—On November 14 the clouds cleared away between 16h. and 16h. 30m., but the moon was very bright, and must have extinguished many of the smaller meteors. Between 16h. 30m. and 18h. a considerable number of shooting stars were observed, but no exact count was kept. The lines and approximate paths of ten of the more conspicuous ones were noted, and the brightest of all appeared in Cepheus at 17h. 25m. It was sufficiently luminous to cast distinct shadows in spite of the moonlight. Very brilliant meteors also fell at 17h. 10m., 17h. 15m., 17h. 35m. and 17h. 40m.

The Dumfries and Galloway Standard of November 17 reports that the nights of November 12 and 13 were overcast. On November 14, soon after midnight, the clouds began to roll off, and the sky afterwards became very clear. An amateur observer began watching at 12h. 30m., and from that time until 16h. 15m. he noted in all only thirty-three meteors, not more than thirteen or fourteen being Leonids. He then, thinking the outlook not sufficiently promising for any striking development of the shower, folded up his note book and star charts and retired. Shortly afterwards, however, the Leonids increased rapidly both in numbers and brilliancy. At about 16h. 50m. "a couple of young bakers going along the Whitesands to their work, were startled by many meteors throwing their fiery lances athwart the sky. They estimate the numbers as not fewer than ten shooting stars to the minute, and state they never saw so many before in all their lives."

The latter description is probably exaggerated, but it seems to convey an expression of fact such as we should expect from persons not acquainted with, but surprised by, an unusual celestial event. Though the rough estimate given as to the number of meteors visible may far exceed the actual figures, there is no doubt from the corroborative testimony afforded by Mr. Tucker at Loughborough, quoted in a previous paragraph, that the Leonid shower displayed quite a special activity on the morning of November 15. That it was apparently observed by few persons is unfortunate, but no other result could be expected in view of the cloud-laden atmosphere which prevailed, generally, at the time. It is to be hoped that more favourable conditions obtained at foreign stations, and that successful observations were secured. The shower seems to have presented itself somewhat later than the time expected, both in 1896 and 1897.

W. F. DENNING.

M. FORSTER HEDDLE, M.D.

EARLY on the morning of November 19 there passed away at St. Andrews the foremost mineralogist of Scotland, and one of the most distinguished in the United Kingdom.

Matthew Forster Heddle was the younger son of Robert Heddle, Esq., of Melsettar, in Orkney, and was born in 1828. In 1844 he went to the University of Edinburgh, where he studied medicine and attended the classes of Gregory and Jameson. Even at this time his tastes lay in the direction of science ; and on the completion of his medical studies he proceeded to Germany, where he devoted himself to chemistry and mineralogy, at first in Clausthal and afterwards under the illustrious Breithaupt at Freiburg. Returning to Edinburgh, he took his degree as Doctor of Medicine in 1851, his graduation thesis being a treatise "On the Ores of the Metals."

He practised for a short time in Edinburgh, but never found this occupation a congenial one, devoting by degrees all his time to analysis and other scientific work. In 1856 he organised an expedition to the Faroe Islands. Five months of the summer of that year were spent in a mineralogical survey of the group, resulting in large additions to his cabinet, and putting on a firm foundation his knowledge of the mode of occurrence of the zeolites of the tertiary volcanoes.

On Dr. Heddle's return from this expedition he was appointed assistant to Prof. Connell at the University of St. Andrews, and on Connell's death, in 1862, he succeeded him as Professor of Chemistry, occupying this chair for twenty-two years. He threw himself with characteristic energy into his work at the University, spending a very considerable part of his salary in the purchase and fitting up of the apparatus for his experiments.

He found time, however, during these years for much mineralogical work, in the course of which he again and again traversed the whole North of Scotland and the Western Islands, thus acquiring an unrivalled acquaintance with its rocks and minerals. The results of these explorations were embodied in a series of papers read principally before the Royal Society of Edinburgh, of which he was, in 1878, elected a Fellow, and the Mineralogical Society, of which he was one of the

founders, and whose President he afterwards became. In addition to these and other papers of a geological and mineralogical nature, he undertook, in 1858, the revision and practically the editorship of Greg and Lettsom's "Mineralogy of Great Britain and Ireland," to which he made many original contributions. He also wrote the article "Mineralogy" for the last edition of the "Encyclopædia Britannica." In 1878 he received the Keith medal of the Royal Society of Edinburgh. Until a few weeks before his death he was engaged on an exhaustive work upon the mineralogy of Scotland, bringing together the results of all his investigations and analyses. This he left almost complete, and it is to be hoped that it may shortly be published.

In the long course of his mineralogical activity Dr. Heddle gathered very large and valuable collections of minerals, both general and Scottish. The latter of these, the fruit of many journeyings, was three years ago acquired by the Museum of Science and Art, Edinburgh, and is now on exhibition there, arranged and labelled by Dr. Heddle himself.

Although a specialist in mineralogy, Dr. Heddle's sympathies were not by any means confined to this subject, and embraced not only cognate sciences, such as chemistry on the one side and geology on the other, but extended to many other branches of science. As a chemist he was most painstaking and exact, and has published several hundreds of analyses of Scottish minerals, collected and carefully picked by himself. He was always most particular to indicate the possible impurities as a geologist. He published detailed maps of Shetland and Sutherland, and contributed to the unravelling of the problem of the North-west Highlands. He was a very observant student of the influence of geological structure upon the scenery of a country. In some respects he was in advance of his time as a geologist, and has lived to see suggestions, which were ignored when made by him, worked out by others and generally accepted. Many of his papers, which were founded on a wide research, are extremely suggestive and instructive. Perhaps among the best known are those where he expounds his law of pseudomorphous replacement, and where he enunciates the connection between the colloidal and crystalline states of a substance and its specific heat.

Dr. Heddle had an acute and exact eye, a clear intellect, and a wonderful memory. He was a good draughtsman, and his crystal drawings were most admirable. He grudged no trouble in smoothing the path of the tyro in his favourite science, and was most generous in his recognition of any work done by others. His kindly and genial disposition endeared him to a wide circle of friends. J. C.

NOTES.

M. Moureaux has just completed the installation of the new magnetic department of the Parc St. Maur Observatory; and it will be set in operation on December 1. The work at the old magnetic rooms will be continued until January 1, in order to supply M. Moureaux with a sufficient number of observations for a reduction of the valuable records obtained continuously during a number of years.

Prof. James B. Hatcher, curator of the department of vertebrate palæontology of Princeton University, sailed from New York a few days ago for Rio Janeiro, *en route* for Southern Patagonia. He expects to land finally at Punta Arenas, and thence work northward along the eastern base of the Andes as far as the Argentine territory of Chubut, studying the palæontology and geology of the country. The expedition will be gone three years, and aims to bring home a complete collection of birds and mammals from the Tertiary deposits of Patagonia.

In the course of next month, the American Philosophical Society will award the Magellanic gold medal to the author of what is adjudged to be the best discovery, or most useful invention, relating to navigation, astronomy, or natural philosophy (mere natural history—the words are the Society's own—only excepted). The prize was founded in 1786 by John H. de Magellan, of London, and consists of a medal "of solid standard gold of the value of ten guineas."

Sir William Crookes will be the guest of the evening at the Club House Dinner of the Camera Club on December 7.

At the meeting of the Entomological Society of London last week, the Chairman referred with regret to the death, while serving on the Indian Frontier Expedition, of Captain E. Y. Watson, Fellow of the Society, and well known for his writings on Oriental Rhopalocera.

The Paris Academy of Medicine has been authorised to accept the legacy of forty thousand francs bequeathed to it by Dr. Eugène Dupierris. The legacy is to be used to found a biennial prize for the best work on anæsthesia, or on diseases of the urinary canals.

A new medical society has been formed in St. Petersburg; it will be known as the St. Petersburg Ophthalmological Society, and its first president is Prof. Dobrovolski.

The *Athenæum* states that the first meeting of the present session of the German Chemical Society at Berlin was devoted to a *Gedächtnisfeier* in honour of the late Prof. Victor Meyer.

Jubilee medals have been conferred upon Dr. Günther, President of the Linnean Society, Prof. Dewar, president of the Chemical Society; and Prof. R. Meldola, late president of the Entomological Society.

Prof. A. Bauer has been obliged, on account of ill-health, to decline the office of president of the third International Congress for Applied Chemistry, which is to be held next year at Vienna, and Dr. H. R. von Perger has been elected in his stead. There will be twelve sections in connection with the Congress. Among the subjects to be discussed is the introduction of uniform methods of analysis of chemical products.

The Paris correspondent of the *Lancet* notes the return of M. Raoul from Malaita, where he has for some time been engaged for the Government in making researches as to the existence of indigenous plants that might be turned to account scientifically or commercially. Several members of M. Raoul's party were bitten by snakes of different kinds, and were injected with Dr. Calmette's serum with very great success.

Dr. A. Lustig, writing in the *Atti dei Lincei*, describes some important observations made in India on vaccination as a preventive of bubonic plague, and also on sero-therapic methods of treatment. At the time when the plague was raging in Bombay last June, Dr. Lustig made a number of experiments both on human subjects and on monkeys. Thirty persons suffering from the disease were inoculated with serum, and of these only four died during the treatment. In conjunction with Dr. G. Galeotti, the same writer made experiments on rats with a view of ascertaining whether there existed any hereditary transmission of the immunity conferred by vaccination. It was found that in no case did vaccination of either or both parent animals at any stage prevent the progeny from taking the disease.

In the Budget of the French Minister of the Interior, the grant of 106,000 francs for the therapeutic serum service of the

Pasteur Institute is set down for payment. In 1895, 45,203 doses of anti-diphtheric serum, each ten centigrams in amount, were distributed gratuitously, and in 1896 the number was 28,217. Since the commencement of the work, as many as 137,058 doses of antitoxic serum have been distributed by the Institute, 5500 of them being for veterinary purposes.

WE regret to announce the death of Dr. F. Stohmann, honorary professor of agricultural chemistry in the University of Leipzig; and also of Dr. J. Frenzel, curator of the "Müggelsee" biological station near Berlin, and formerly professor of zoology in the Cordoba University, Argentine Republic.

THE death of Dr. Leonhard Sohncke, at the age of fifty-five, is announced. Dr. Sohncke at the time of his death was professor of experimental physics and director of the Physical Laboratory at the Munich Technical High School.

THE Natural History Society of Hanover will celebrate its centenary on December 10–12.

IN a previous number of NATURE (vol. lvii. p. 32) we referred to the death of Prof. Ernst Schering, of Göttingen. Some interesting details of his life and work have now been published by Prof. Wilhelm Schur (*Astronomische Nachrichten*, No. 3458), to which brief reference may be made. Born in the year 1833 at Sandbergen, near Lüneburg, Schering studied in Göttingen under Gauss from the year 1852, was made "ausserordentlicher" professor in 1860, and "ordentlicher" in 1868. In 1869 the magnetic part of the observatory department was made distinct from the astronomical, and the former put under the direction of Schering with the object of continuing the magnetic observations made in the first instance by Gauss. After Klinkerfues' death Schering took over the direction of both departments. During the years 1858 to 1863 Schering took part with Klinkerfues in the zone-observations, which were published in 1891. In 1874 he published a generalisation of Poisson-Jacobi's perturbation formulæ, in 1877 a "Festrede" at the celebration of the hundredth anniversary of Gauss's birthday, and in 1884 a solution of Kepler's equation (*Astronomische Nachrichten*, 2605). His chief work was, however, the publication of Gauss's works in seven volumes. Schering leaves behind him, besides a widow, one daughter and two sons.

Science states that the American Society of Naturalists and the affiliated societies will meet at Ithaca, N.Y., on December 28, 29 and 30. At the opening meeting an address of welcome will be delivered by President Schurman. On the second day of the meeting the principal item on the programme is a discussion on "The Biological Problems of To-day," in which the following speakers will take part: Prof. H. F. Osborn (on Palæontology), Prof. W. Trelease (on Botany), Prof. B. G. Wilder (on Anatomy), Prof. McKeen Cattell (on Psychology), Prof. J. Loeb (on Physiology), Prof. T. H. Morgan (on Developmental Mechanics), Prof. C. B. Davenport (on Morphogenesis).

PROF. TH. W. ENGELMANN, of Utrecht, has just published (Wilhelm Engelmann, Leipzig) a small case ($6\frac{1}{2} \times 9\frac{1}{2}$ inches) containing two sets of tables on which it is intended the results of spectroscopic and spectrophotometric observations may be plotted. The first table, of which there are nine duplicates, consists of six coloured continuous spectra arranged under one another, which serve as a background, so to speak, on which absorption spectra may be drawn. A series of vertical lines forms the scale of wave-lengths, and the positions of the chief Fraunhofer lines are marked in the upper strip. The second table, of which there are also nine similar ones, is somewhat differently arranged. At the upper part is a coloured continuous spectrum as before, with the positions of the chief Fraunhofer lines marked, and below is a series of horizontal and vertical lines, the former to represent the wave-lengths, and the latter the intensities per cent. This will be found useful for recording the positions and extensions of absorption-bands, and determining the light-curve of the spectra under investigation. Both these sets of tables are impressed on good thick sheets of paper, and the coloured spectra and graduations are very neatly reproduced. It is a pity that the red end of the spectrum is placed on the left, and not on the right hand, as this may tend considerably to diminish the usefulness of these cards. Accompanying these sheets are also two numerical tables expressing (1) the coefficients of extinction for different intensities, and (2) the relative intensities after the passage through coloured media of different thicknesses.

THE *Proceedings* of the Liverpool Geological Society for the last session contains a paper by the president, Mr. J. Lomas, on the Hereford earthquake of last December. The map which accompanies it shows the isoseismal lines, so far as they can be drawn, corresponding to the intensities 4, 5, 6 and 7 of the Rossi-Forel scale. These curves are somewhat elliptical in shape, and are grouped symmetrically about a line running N.N.W. from a point a little east of Hereford. Mr. Lomas attributes the earthquake to the friction generated by the slipping of strata somewhere along the Severn Valley, and he considers it probable that the slip extended for some distance along the axis of the isoseismals.

THE effect of temperatures upon the hibernation of injurious insects forms the subject of a short paper by Dr. L. O. Howard in the *Proceedings* of the ninth annual meeting of the Association of Economic Entomologists, just issued by the U.S. Department of Agriculture. It is a well-known fact among agriculturists and horticulturists that winter weather of a steady degree of severity is more favourable to plant growth than a winter with alternating frosts and thaws. With regard to certain injurious insects, it has become an accepted idea among economic entomologists that this same principle holds good, but farmers and others believe a winter which has been unusually severe will result in the destruction of injurious insects to such an extent as to promise comparative immunity in the next season. Experiments were required to throw light upon the matter, and these have been carried out by Dr. Albert M. Read, of Washington, the manager of the cold storage department of the American Security and Trust Company. Dr. Read has found, in the course of his experiments, that a consistent temperature in the neighbourhood of 18° F. will not destroy the larvæ of *Tineola biscelliella* or of *Attagenus piceus*, but that an alternation of a low temperature with a comparatively high one invariably results in the death of the larvæ of these two insects. For example, if larvæ of either which have been kept at a temperature of 18° F. are removed to a temperature of from 40° to 50° F. they will become slightly active, and when returned to the lower temperature and kept there for a little time, will not revive upon a retransfer to the warmer temperature. Dr. Howard remarks that it is satisfactory to have experimental proof in support of previously accepted, but more or less theoretical, ideas.

AT the Imperial Institute on Monday night, Mr. E. S. Bruce gave a lecture on his system of electric balloon signalling as applied to scientific exploration in Arctic and Antarctic regions. Major P. A. MacMahon was in the chair. After pointing out how great an advantage it would be for a party to have a means of communicating with the ship when away on an exploring expedition, the lecturer described his system, in which a group of electric lamps was mounted inside a balloon connected with the earth by an electric cable. The operator and most of the

apparatus would be on the ground or the deck of a ship, and therefore the balloon could be made easily portable. Gold-beaters' skin would be the best material to employ for the covering, and the smallest size of balloon he could recommend for Arctic exploration purposes would be about 7 feet in diameter, with a capacity of 150 cubic feet and able to lift 500 feet of cable. The necessary gas could be stored in steel tubes, or a portable gas-making machine might be carried. The source of electric power would be a dynamo, with which Mr. Bruce supposed every future Arctic expedition would be provided, and this could be operated by wind power, if coal ran short, or even by hand. By giving long and short flashes on the lamps, it would be possible to convey messages in the Morse alphabet.

SOME time ago, G. Jung gave a solution of the problem "to determine by the method of least squares the plane which most nearly coincides with n non-coplanar points." In the *Rendiconti del R. Istituto Lombardo*, ii. xxx. 16, a brief abstract is given of an investigation by the same writer of the reciprocal problem: "Given n non-concurrent planes, to find the point most nearly determined by them." The corresponding problem in plane geometry has been attacked by M. d'Ocagne, and Prof. Jung has thus extended the method to three-dimension space, besides giving a generalisation of certain constructions first investigated by M. Berthot.

IN the *Journal of the Royal Statistical Society* (September), Mr. W. F. Sheppard considers the calculation of the average square, cube, &c., of a large number of magnitudes. Supposing that a number of measurements are tabulated to the nearest multiple of a particular unit (*e.g.* the chest measurements of 5732 Scotch soldiers to the nearest *inch*), the data do not enable us to find *exactly* the true average measurement or the average square or cube of the magnitudes. Mr. Sheppard shows that the *rough value*, obtained by supposing each measurement to be equal to the nearest multiple of the unit, differs in some cases considerably from the *most probable* value of the average in question, and he finds that for laws of distribution which satisfy certain conditions a very close approximation to the latter may be obtained by applying certain simple corrections to the "rough values" first calculated.

IN the *Mathematical Gazette* for October we are glad to see that Mr. R. F. Muirhead calls attention to the old treatment of the "Parallelograms of Velocities and Accelerations," which still survives in many otherwise excellent text-books on dynamics. The enunciation often introduces the notion of "a moving point or body possessing simultaneously two velocities," a notion which is meaningless until coexistent velocities (which would better be spoken of as "velocity components") have been defined. The usual (so-called) "proof" tacitly involves the idea of a body *moving relatively* to a certain base which is itself in motion, but as the word "relative" is generally omitted, and the parallelogram of velocities is usually given before relative motion is considered, and, moreover, is employed in the discussion of relative motion, the learner's mind is often puzzled and he fails to grasp the theorem. Mr. Muirhead rightly contends that the only logical way out of the difficulty is to make relative motion precede the discussion of the parallelogram law, unless, indeed, the latter be regarded merely as a *definition* of component velocities and acceleration.

WE have received from Mr. R. C. Mossman a copy of a very valuable and laborious investigation of the Meteorology of Edinburgh, based upon observations during the past 132 years, from documents mainly collected by the Scottish Meteorological Society. The work is published in the *Transactions* of the Royal Society of Edinburgh, and is divided into two parts, the first dealing with the climatic elements for each day of the year, and the second with monthly and annual means, and with secular and other weather changes. The smoothed curves show that the warmest day of the year falls on July 15, and the coldest on January 8. The mean daily maximum temperature is above the annual average (46°·8) from April 26 to October 14, but the mean minimum does not get above the yearly mean until May 12, and it remains above it till October 19. The greatest excess of sun over shade temperature was 76°·8 in March 1892, and the grass minimum thermometer fell 12°·6 below the minimum in shade in May 1890. The mean annual rainfall is 25·86 inches; the wettest period is that embraced in the seven days ending August 18; while the period distinguished by the least rain-fall, is the week ending with March 27. One very interesting feature of the discussion is a chronological appendix of remarkable atmospheric phenomena at Edinburgh, extending from 1575 to 1895, which has been compiled from a variety of sources.

A NOTE in *Science* states that Dr. O. Holst, of the Geological Survey of Sweden, after two years' leave of absence granted him for the purpose of studying the new gold-fields in Western Australia, has now returned. Dr. Holst saw the ancient Australian glacial deposit which is supposed to belong to the Permian age, and says there can be no doubt but that it is an indurated boulder-clay. Its age may possibly be somewhat later than heretofore supposed, but not so much later as to detract from the importance of its bearing on the subject of geological climate. In the semi-desert, where Dr. Holst spent most of his time, the wind did not appear to him to be of any great importance as a geological agent, although dust storms are sometimes reported from the new towns on the border of the desert. One of the Australian geologists has lately made some interesting observations on what resembles a tidal action of the ground water in the sandy region in the interior. The water rises and falls at regular daily intervals, and the oscillations appear to be too great to be explained as resulting from the daily variations in atmospheric pressure.

THE *Electrician* calls attention to a new development in the design of electrically-propelled pleasure craft, which has been given the name of the "Nymph." Briefly, the "Nymph" is an attachment to an ordinary pleasure boat, sailing ahead of it but rigidly connected to it, the boat containing the accumulator cells and the switch-gear by which is controlled the motor in the body of the swan-shaped tug. The craft is guided or steered by two reins attached to the head of the "swan," and these reins actuate by gear the ordinary rudder. A regulator situated close to the right-hand of the driver enables him to control the speed of the motor and propeller in the "swan," and to go at full or half-speed, ahead or astern. There are sixteen chloride cells of seventeen plates each, and these, for starting and low speeds, are connected to the motor in two parallels of eight cells each, all the cells being used in series for full speed. The total electrical capacity of the battery is about 300 ampere hours, and this is equal to propelling the boat at a speed of eight miles an hour for six hours, or a total distance of about fifty miles, with six people on board. No resistances are used, and neither the field nor the armature is divided up in any way to regulate the speed. The vibration of the boat is perceptibly less than in one containing the motor. Although the arrangement lends itself to graceful design, there is probably considerable loss of efficiency as compared with the usual stern propeller.

THE Commission appointed by the German Government to study the plague in Bombay, and which commenced its work under the presidency of Prof. Dr. Gaffky last March, has published the results of its labours in several numbers of the *Deutsche medicinische Wochenschrift*. The report is a very elaborate and exhaustive one, and contains a mass of valuable

experimental material. It would appear that in the majority of cases the plague-bacillus obtains access to its victims through small wounds or scratches on the body, reminding one of the same method adopted by the anthrax bacillus for infection. As Yersin has already pointed out, plague is essentially a disease which afflicts the poor and miserably-housed lower classes of the population, their habits and repugnance to all sanitary precautions, and prejudice against the hospitals, rendering its suppression a matter of extreme difficulty. In the hospitals, thanks to systematic disinfection and scrupulous cleanliness, cases of plague amongst the staff were very rare. The Commission have discovered that the serum of human beings, as well as that of animals which have recovered from plague, exerts a specific action on plague bacilli outside the body, producing the phenomenon of the clumping together of the bacilli now so familiar in the case of typhoid bacilli under similar circumstances. Numerous researches were carried out to test the vitality and powers of endurance possessed by these bacilli under very varied conditions. For example, in sterilised tap-water they were found to be dead after three days, whilst in ordinary tap-water a single day's immersion was sufficient to destroy them. Very sensitive also are these microbes to the action of disinfectants, corrosive sublimate diluted to 1 in 1000 parts at once destroys them, whilst a 1 per cent. solution of carbolic acid also kills them within ten minutes. Heating for ten minutes at 55° C. destroys them, as also does exposure to a temperature of 80° C. for five minutes, whilst in a liquid just brought to the boiling point, and at once examined, they were also entirely annihilated. Perhaps the most interesting part of the report is that which deals with the inquiries made into the respective merits of Yersin's and Haffkine's anti-plague inoculations. Yersin's serum inoculations in Bombay do not appear to have been as successful as those which he previously carried out in cases of plague at Amoy. Dr. Roux was, however, preparing a yet stronger serum at the Paris Pasteur Institute, and it was hoped that it might prove more efficacions. On the other hand, Haffkine's inoculations appear to have been very successful, although the protection against plague afforded by them is by no means absolute. Haffkine's method consists in adding a weak solution of carbolic acid or essence of mustard to a virulent growth of plague bacilli, thereby destroying the microbes; their products, however, which remain, possess a remarkable protective power. The vaccine may also be procured by heating the plague-cultures to 65° C. for one hour, or during two hours to 51° C. This method of heating appears to yield the best vaccine. It is impossible here to enter into further details of this valuable report, which forms a most important contribution to the scientific literature already existing on plague and its dissemination.

MR. CHARLES LOUIS HETT, of Springfield, Brigg, has prepared a list of the calls of some two hundred British birds, and appeals for the assistance of other students of bird-life, either in checking calls already recorded, or in supplying those of other birds. He promises to finish the compilation and to issue it from the press, provided he receives the co-operation needed.

HERREN MAYER AND MÜLLER, of Berlin, ask for subscriptions for an important work on Orchids, of which the first volume is already in type—"Orchidacearum Genera et Species," by Prof. F. Kraenzlin, to be completed in six volumes. No complete separate systematic work on the Orchidaceæ has been published since Lindley's Synopsis, which was issued sixty years ago.

COHN'S "Kryptogamen-Flora von Schlesien" is a work of much more than local interest, the various families of Cryptogams having been worked out with the greatest care by experts in the various departments. The last part received (3ᵉʳ Band, 2ᵗᵉ Hälfte, 4ᵗᵉ Lieferung) completes the Pyrenomycetes, and contains an introduction to the so-called "Fungi imperfecti," those in which the conidial, but not the ascogenous form is known. This portion of the work will, unfortunately, remain uncompleted, as it stood in the hands of Dr. J. Schröter at the time of his death in 1894, Prof. Cohn not having been able to find any one to complete the work left unfinished by that eminent mycologist. An interesting feature of Dr. Schröter's work in this section of Fungi is that he has discarded the term genus, arranging the species under *Formgattungen* or "form-genera."

MESSRS. ROSS, LTD., have just issued a very full illustrated catalogue of the instruments made by them.

MESSRS. ABBOTT, JONES, AND CO. announce for early publication "The Life of James Abernethy, past-president of the Institute of Civil Engineers." The book will be the work of John S. Abernethy, and will be illustrated.

THE sixteenth Annual Report of the Bureau of American Ethnology has reached us, and contains the following papers:—"Primitive Trephining in Peru," "Cliff-Ruins of Canyon de Chelly, Arizona," "Day Symbols of the Maya Year," and "Tusayan Snake Ceremonies."

THE catalogues issued from time to time by Mr. Bernard Quaritch are always interesting, but few, if any, of those recently issued can compare with the one dated November 12. which has just reached us. It is entitled "Monuments of Printing," and contains particulars of books produced by the earliest presses in Germany, the Netherlands, Italy, France, Spain and England from 1455 to 1500, and a few remarkable examples of a somewhat later date. The catalogue is one which will be prized by all students of typography.

THE *Photogram* for November contains several short articles of interest to photographers. Mr. C. F. Townsend writes about sensitometers, giving a brief historical summary of the methods employed. Under the heading of "Applied Photography in Ship Salvage Work" is the title of an article by Mr. Charles H. Evans, who points out the many difficulties that are met with in this class of work. The illustrations accompanying the text are very much to the point, being good examples of the work undertaken. Other branches of the art dealt with are photomicrography, exact measurements with the X-rays, toning bromide prints, &c., together with useful information in the form of notes on many other points of interest.

VOLUME V. of the *Transactions* of the Institution of Mining and Metallurgy for the sixth session has reached us, and is a bulky work, containing reports of some eighteen papers, and the discussions which took place upon them. The Institution during the session referred to had upon its books the names of 449 members, associates and students, as against 372 for the session of 1895–96.

MESSRS. MACMILLAN will publish shortly a work entitled "A Text-Book of Zoology," under the joint authorship of Profs. T. Jeffery Parker and W. A. Haswell. Special attention is called to the illustrations, of which there are over a thousand in the two volumes that comprise the work. For the most part these illustrations are original, and have been drawn by Mr. N. J. Parker.

OF all the periodicals which come before us week by week, and month by month, not one fulfils its particular purpose better than the *Engineering Magazine*. The magazine is always attractively illustrated; the articles in it deal with subjects which are of prime importance in the engineering world; and the monthly digest of the entire technical press is a very valuable

index to current technical literature. The issue of a distinctly European edition of the magazine was commenced last month, and we are confident that it will meet with as much success here as it has in the United States.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. F. Greswolde-Williams; a Suakin Gazelle (*Gazella brookii*) from Abyssinia, presented by Dr. L. de Gebert; two Ring-necked Parrakeets (*Palæornis torquatus*) from India, presented by Mrs. G. F. Cooper; a Macaque Monkey (*Macacus cynomolgus*, *albino*) from Manilla, presented by Mr. James Coombs; two Double-spurred Francolins (*Francolinus bicalcaratus*) from West Africa, four Rosy Bullfinches (*Erythrospiza githaginea*), bred in England, presented by Mr. E. G. B. Meade-Waldo; two Herring Gulls (*Larus argentatus*), British, presented by Mr. T. Hope Robinson; two Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), two —— Snakes (*Chlorophis hoplogaster*), a Puff Adder (*Bitis arietans*) from South Africa, presented by Mr. J. E. Matcham; a Ring-tailed Lemur (*Lemur catta*, ♀) from Madagascar, a Macaque Monkey (*Macacus cynomolgus*) from India, deposited; six Rosy-faced Love Birds (*Agapornis roseicollis*) from South Africa, a Malaccan Parrakeet (*Palæornis longicauda*) from Malacca, four Siskins (*Chrysomitris spinus*), four Lesser Redpolls (*Linota rufescens*), British, a Bridled Wallaby (*Onychogale frenata*) from Australia, a Loggerhead Turtle (*Thalassochelys caretta*) from the Mediterranean, purchased.

OUR ASTRONOMICAL COLUMN.

THE NOVEMBER METEOR SWARMS.—Up to the present time we have not received any news that the Leonids were more abundant this year than last. Indeed, bad weather seems to have universally prevailed about the time of observation. At the Paris Observatory five observers only noted twenty meteors, while M. Hansky, at the Meudon Observatory, saw in all seven, four of which were Leonids. M. Janssen, in consequence of the exceedingly bad weather experienced in Western Europe, telegraphed to San Francisco to inquire whether a more brilliant display had been noted there. The answer he received was to the effect that nothing more than the ordinary shower was observed. Perhaps, however, observers may be (or may have been) more fortunate with the Andromedes, which are expected between the 23rd and 27th of this month. This swarm is also of considerable strength, and should be more than usually active Its period of revolution being six and a half years, and the last maximum having occurred on November 23, 1892, we expect the shower this month to be above the ordinary yearly display. There are several points about the Andromedes that are of peculiar interest. One of these is that the orbit in which they move is very similar to that of the comet Biela; in fact, the bodies which produce the phenomena of shooting stars may be none other than the component parts of this comet. In the years 1872 and 1885 the maximum display occurred on the 27th of the month, but at the following expected shower it took place on the 23rd. This difference is explained, according to Bredichin, by the perturbatory effects due to the proximity of the planet Jupiter, thus causing the node to recede 4°. The radiant point of this swarm (25° + 43°) has a large northern declination, which renders it always above the horizon. The meteors themselves are different from the Leonids in that they move more slowly, and are of a yellowish tinge.

In the note under this heading, that appeared last week, it should have been mentioned that the observations recorded were made by Dr. W. J. S. Lockyer at the Solar Physics Observatory, South Kensington.

In another part of this journal Mr. Denning summarises the results of this year's Leonid display.

CURRENT ASTRONOMICAL ARTICLES.—M. Gaston Armelin contributes an interesting article on that curious variable Mira Ceti to *La Nature* for November (No. 1274). After a brief historical summary the writer describes some theories current to-day, and points out the variations in the time of maxima observed of late years, and their consequent suggested explanations.—The bulletin of the *Société Astronomique de France* for the same month contains, among other interesting matter, a drawing of comet Perrine as observed at the observatory of Juvisy. M. Camille Flammarion deals with the Leonid swarm of meteors. The number contains several contributions of planetary notes.—In the October number of *Himmel und Erde*, a brief account is given of the present state of the proposed large Potsdam refractor. There seems to have been some difficulty about the optical parts, so that it has been decided to assume that the aperture will be 80 cm., and commence at once with the construction of the instrument and a suitable dome. This instrument when finished will be then the largest in Europe, the aperture being nearly thirty-two inches. This article contains the results of many investigations on the absorption properties of different thicknesses and kinds of glass.

COMET PERRINE (OCTOBER 16).—This comet is gradually becoming fainter, but a continuation of the ephemeris for the current week will perhaps prove useful:—

12h. Berlin M.T.

1897.	R.A. h. m. s.	Decl. ° ′	log *r*.	log Δ.	Br.
Nov. 25 ...	18 16 49 ...	+59 24·6			
26 ...	15 45 ...	58 44·8 ...	0·1376 ...	0·0278 ...	0·7
27 ...	14 47 ...	58 6·4			
28 ...	13 54 ...	57 29·3 ...	0·1366 ...	0·0370 ...	0·7
29 ...	13 6 ...	56 53·4			
30 ...	12 23 ...	56 18·8 ...	0·1357 ...	0·0459 ...	0·7
Dec. 1 ...	11 43 ...	55 45·5			
2 ...	11 7 ...	55 13·5 ...	0·1351 ...	0·0546 ...	0·7
3 ...	18 10 34 ...	+54 42·4			

REV. DR. SEARLE has resigned the directorship of the astronomical observatory of the Catholic University of America. His place will be taken by Mr. Alfred Doolittle.

THEORY OF THE MOTION OF THE MOON.[1]

OF the lunar theories hitherto completed the two greatest are undoubtedly those of Hansen and Delaunay. The former has for its chief object the formation of tables: the inconvenience of slowly converging series is avoided by using numerical values throughout; and the problem solved is the one actually presented by nature, every known cause of disturbance being allowed for. It suffers, however, under the disadvantage that there are no means of correcting the results for any change in the values of the constants that observation may demand. This drawback was avoided by Delaunay, but only at the expense of still greater evils from the point of view of the making of an ephemeris; for owing to the slow convergence of certain series, twenty years' labour did not suffice to give sufficiently approximate results; moreover, the problem had to be considerably modified from the circumstances of nature, in order to achieve a result within even so long a time.

The memoir that Dr. Brown has lately presented to the Royal Astronomical Society, forms the first part of a fresh attempt to calculate the motion of our satellite. All Delaunay's modifications of the problem are adopted: that is to say, the sun and earth are supposed centrobaric, the mass of the moon is neglected, as is also the action of the planets, and the true mass of the sun is increased by that of the earth. The calculation of the effect of the attraction of the planets and of the protuberant parts of the earth's equator will follow when the modified problem is solved. The solution can also be easily modified so as to allow for the greater part of the effect of the remaining modifications, and the outstanding error Dr. Brown has shown to be insensible to observation; but it is, however, far larger than the minute fraction of a second to which his calculations are pushed.

Dr. Brown's theory resembles Delaunay's in being algebraical with, however, one important exception: the ratio of the mean motions is replaced by its numerical value. By this means the slowly converging series that occur in Delaunay's theory are avoided; and no admissible correction of the value of the above ratio can introduce any change in the results that would be sensible to observation. This modification in the form, combined

1 "Theory of the Motion of the Moon." Containing a new calculation of the expressions for the coordinates of the Moon in terms of the time." By Ernest W. Brown, M.A., Sc.D. (Reprinted from the *Memoirs* of the Royal Astronomical Society, vol. liii.)

with the use of a totally different method of calculation will, Dr. Brown estimates, cut down the twenty years occupied by Delaunay over the same problem to five.

One great advantage of an algebraical theory is the facility with which the work can be divided into sections, each consisting in the calculation of a group of terms multiplied by the same power of the eccentricities, inclination, and solar parallax, or, in the language of the lunar theory, having the same characteristic. Delaunay's theory unfortunately lost this advantage by its peculiar methods, and substituted another form of subdivision that enormously increased the total labour in the desire to present each step in a moderate compass. Adams appears to have been the first to clearly recognise the advantages of a subdivision such as Dr. Brown has employed, but it was Dr. Hill who actually laid the foundations of the present theory. In the first volume of the *American Journal* he published his famous "Researches in the Lunar Theory," where, after the lapse of more than a century, he revived Euler's idea of using rectangular coordinates. Confining his investigations to the case when the eccentricities, inclination, and solar parallax are supposed to vanish, he used axes rotating so that the axis of x points constantly to the sun, and then replaced x, y by the conjugate complex variables $u, s = x \pm y\sqrt{-1}$, and the time by another complex quantity $\zeta = e^{(n-n')t\sqrt{-1}}$, and the symbol of differentiation by D defined as $\zeta\frac{d}{d\zeta}$. He also used the symbol m to denote the ratio of the synodic month to the sidereal year, and k to denote the mass of the earth divided by the square of the difference of the mean motions of the moon and the sun. He then arrived at the differential equations,

$$(D+m)^2u + \tfrac{1}{2}m^2u + \tfrac{3}{2}m^2s - \frac{ku}{(us)^{\frac{3}{2}}} = 0$$

$$(D-m)^2s + \tfrac{1}{2}m^2s + \tfrac{3}{2}m^2u - \frac{ks}{(us)^{\frac{3}{2}}} = 0.$$

At this point arose a difficulty which, in a closely analogous form, is common to all lunar theories, the presence, that is to say, of the quantity denoting the mass of the earth divided by the cube of the distance. The practical convenience of a theory is perhaps in no way better tested than by examining the manner in which this difficulty is overcome, and it is certainly not too much to say that in this respect Dr. Hill's method has no rival. In a few brief steps he succeeds in eliminating the obnoxious quantity altogether, and he obtains two equations of the second degree in u, s and homogeneous in these variables except for a constant of integration, which may be looked upon as replacing k. These equations are easily solved numerically, and denoting the values of the variables with Dr. Hill's modifications of the general problem by the suffix zero, u_0 and its conjugate complex s_0 may be henceforth looked upon as known functions of the time. They are, in fact, capable of expression as infinite series of positive and negative odd powers of ζ. The coefficient of ζ in u_0 is denoted by a, which is a constant defining the linear dimensions of the orbit. By having recourse to one of the original equations containing k, the value of k/a^3, which is a mere number, may be found. This completes the investigation of the variation, as this class of inequalities is called.

It is at this point that Dr. Brown took up the subject. He replaced Dr. Hill's first pair of equations by the following set of three, the third of which determines z or the moon's coordinate perpendicular to the ecliptic, which in the particular case treated by Dr. Hill is zero

$$(D+m)^2u + \tfrac{1}{2}m^2u + \tfrac{3}{2}m^2s - \frac{ku}{(us+z^2)^{\frac{3}{2}}} = -\frac{\partial\Omega_1}{\partial s}$$

$$(D-m)^2s + \tfrac{1}{2}m^2s + \tfrac{3}{2}m^2u - \frac{ks}{(us+z^2)^{\frac{3}{2}}} = -\frac{\partial\Omega_1}{\partial u}$$

$$(D^2-m^2)z - \frac{kz}{(us+z^2)^{\frac{3}{2}}} = -\tfrac{1}{2}\frac{\partial\Omega_1}{\partial z}.$$

In these equations Ω_1 represents the part of the disturbing function neglected by Dr. Hill, every term of which is divisible by either the solar eccentricity or parallax. The quantity k can be eliminated from the first two of these equations in a manner analogous to the methods of Dr. Hill. It can be also eliminated from the third and either of the other two in an obvious manner. The resulting equations need not be written down here; following Dr. Brown, they will be alluded to as the homogeneous equations. There are thus two distinct sets of equations that can be used at any step in the work. In practice one set is used, and a single equation from the other set is used in addition, generally as a mere equation of verification, but in certain special cases for the actual solution when the equations of the first set are not well adapted for the purpose. Dr. Brown's procedure is as follows: let

$$u = u_0 + u_\mu + u_\lambda \qquad z = z_\mu + z_\lambda$$

Where u_μ, z_μ denote the terms already calculated, u_λ, z_λ the new terms of characteristic λ to be calculated in the next step of the process of solution. Either u_λ or z_λ is always zero according as λ contains an odd or even power of the inclination. These values are then substituted in either set of differential equations, and the terms of order λ picked out. It can be readily seen that the right-hand side of the equations contain only known terms, and the unknown new terms occur in the first degree and multiplied by functions of u_0 s_0 only. If the first set of equations be used, the terms containing k/r^3 must be expanded by Taylor's Theorem into series proceeding according to powers of $u_\mu + u_\lambda$, $s_\mu + s_\lambda$, $z_\mu + z_\lambda$ with coefficients containing k, u_0, s_0 only. These coefficients are easily deducible from Dr. Hill's value of u_0, the method of special values being in general used. One remark, however, requires to be made. Every time a set of terms is calculated whose arguments are the same as the terms in u_0, there arises the opportunity of modifying the meaning of the linear constant a. It is otherwise evident that any solution remains a solution when a is replaced by a new constant a' defined by the relation $a/a' - 1 =$ an arbitrary series of powers and products of the squares of the eccentricities, inclination, and solar parallax. The value of k is of course simultaneously modified also. Consequently we should be liable to have the values of such quantities as k/r_0^3 varying from time to time as the approximation proceeds. This would be obviously inconvenient, and Dr. Brown has used the power of modification at his disposal so that k/a^3 remains invariable throughout the solution, and therefore, since in Dr. Hill's papers it is a function of m only, it always remains so.

In the first set of equations therefore the unknown terms enter in the form

$$\zeta^{-1}(D+m)^2u_\lambda + M\zeta^{-1}u_\lambda + N\zeta s_\lambda$$

and

$$D^2z_\lambda - 2Mz_\lambda$$

where

$$M = \tfrac{1}{2}m^2 + \tfrac{1}{2}\frac{k}{\rho_0^3}$$

$$N = \tfrac{3}{2}m^2\zeta^{-2} + \tfrac{3}{2}\frac{ku_0^2\zeta^{-2}}{\rho_0^5}$$

the same form at every approximation. (A misprint in the algebraical value of N, on p. 63, should be noticed; the factor ζ^{-2} being there omitted. This is merely a printer's error, for the arithmetical value on p. 90 is correctly given. Indeed, were it otherwise, the discordance of the results from those of other theories would long ago have been noticed.)

When the new terms to be calculated have the same arguments as u_e or z_k, the principal elliptic or inclinational terms, a new term in the motion of the perigee or node (of order λ/e or λ/k) has to be calculated. The unknown term $c_{\lambda/e}$ appears multiplied by $2(D+m)u_e$ in the first equation, and $g_{\lambda/k}$ appears multiplied by $2Dz_k$ in the second equation. These coefficients are independent of λ: since, however, λ must be of at least the third order for the point to arise, it does not properly enter into the part of the work already published.

A series with indeterminate coefficients is then assumed for u_λ or z_λ: and a number of simultaneous equations formed, from which the coefficients are found. The labour of forming the known terms in these equations increases rapidly with the characteristic; but the operations required are mere multiplication of series, and can to a great extent be left to a computer. The results are readily checked by computing independently the value when $\zeta = 1$.

The unknown terms enter at each step into the equations under the same algebraical form, or rather under one of two forms, according as the new terms belong to u or z. These forms unfortunately involve the symbol of differentiation D, so that the different sets of simultaneous equations have different arithmetical coefficients; but whenever more terms with an old set of arguments are being calculated, the arithmetical coefficients are the same as before, and it is only the right-hand sides which are different. This greatly facilitates the labour of solution; but the advan-

tage is obviously one that is deferred to the later stages of the work, the only instances in the part of the work hitherto published being that the calculations of sections (v.) and (viii.) of chapter iv. are to some extent facilitated by the previous calculation of section (ii.) of the same chapter.

The ordinary method of approximation in the simultaneous equations proceeds by determining approximate values of the unknown quantities in order of magnitude, at first neglecting the smaller of these quantities in the equations of principal importance for determining the larger ones. It happens, from a well-known cause, that sometimes the coefficients of certain unknowns are small even in the equations of principal importance in determining them. Prof. Brown has, in these cases, found it best to defer their determination until he has found all the other quantities in terms of them.

After considerable experience of both sets of differential equations, Prof. Brown has come to the conclusion that the first set on the whole is the best adapted to the numerical work. An important exception, however, arises. The two coefficients of a term of long period are principally determined by two equations very nearly deducible, the one from the other, the determinant of the coefficient varying inversely as the square of the period. The difficulty is considerably lessened by using one equation derived from the homogeneous set.

The following table will give some idea of the extent of the calculations already performed. The terms have been calculated

Reference Number.	Characteristic.	Argument.	Number of Terms.	Approximate value in arc of the largest coefficient (1) including (2) excluding purely elliptic terms.		Value of unity in the last figure given in millionths of a second of arc.
				″	″	
1*	1	0	13	206265	1800	0·0002
2	e	$\pm l$	18	17000	3000	2
3	e'	$\pm l'$	21	350	350	0·4
4	α	D	9	80	80	0·05
5	k	F	11	9000	300	0·01
6	e^2	$\pm 2l$	21	240	170	3
7	e^2	0	11	340	100	3
8	ee'	$\pm (l + l')$	21	140	140	4
9	ee'	$\pm (l - l')$	22	100	100	4
10	e'^2	$\pm 2l'$	18	6	6	0·6
11	e'^2	0	10	2	2	0·6
12	k^2	$\pm$ 2F	20	400	40	0·4
13	k^2	0	11	400	40	0·4
14	$e.\alpha$	D $\pm l$	19	12	12	0·6
15	$e'.\alpha$	D $\pm l'$	20	14	14	0·1
16	α^2	0	9	0·01	0·01	0·1
17	ke	F + l	10	15	15	0·06
18	ke	F − l	11	45	45	0·06
19	ke'	F + l'	10	1	1	0·01
20	ke'	F − l'	11	0·4	0·4	0·01
21	$k\alpha$	D + F	10	4	4	0·02

* Calculated by Dr. Hill.

in twenty-one groups, the order of calculation being indicated by the number in the first column. The second column gives the multiple of the eccentricities, inclination, and ratio of parallaxes that is common to each coefficient of the group. The third column gives the fundamental argument from which all the other arguments are derived by the addition or subtraction of multiples of twice the elongation, Delaunay's notation being used, The fourth column gives the number of terms calculated. The fifth column gives the approximate value in arc of the largest coefficient, and the sixth column the value of the largest coefficient indicating a disturbance from elliptic motion. The last column gives the value in arc of the last significant figure, and where, as often happens, the coefficients of a group have been calculated to a different number of decimal places, then the number given in this column corresponds to the coefficient calculated with least accuracy.

Dr. Brown gives as the approximate values of the constants in the third column of the above table

$e = 0{\cdot}11 \quad e' = 0{\cdot}017 \quad k = 0{\cdot}045 \quad \alpha = 0{\cdot}0026$

It will be seen that the terms calculated include all that ar algebraically of the second order. The ratio of the parallaxes is here considered as being of the first order. The terms depending on the square of this ratio, it will be noticed, are insensible to observation. This is fortunate, as the terms cannot be corrected for the neglected mass of the moon.

We think that the results selected for publication are a little too meagre. They consist of the actual solution itself, and one other set of terms whose calculation divides the labour of each section into two fairly equal halves. We hope that an appendix will be finally published in which the value of every auxiliary quantity will be given. Such an appendix might be of great use in other investigations. It would also be of immense value should there ever be a suspicion of error in Dr. Brown's own calculations, for it would then be far easier to establish the fact of such an error, should one ever creep in, and it would entail less labour to carry through the correction.

MARINE BIOLOGY AT THE BERMUDAS.

AN expedition of the biological department of New York University went to the Bermudas a few months ago to study the marine fauna, and to investigate the conditions offered for the establishment of a permanent biological station there. The party has now returned, and an account of the observations made is contributed by Prof. C. L. Bristol to *Science*, from which source the following particulars have been derived:—

The most attention was given to a search for the various forms and a careful survey of the general conditions subtending their abundance and collection, so that, taken as a whole, the work might prove a reconnaissance and furnish knowledge for future investigations. In this the expedition was fairly successful and would have been much more so but for a long spell of south-west wind which prevented off-shore work, excepting for a few days. Our work was confined mainly to the lee shores, and here we were greatly rewarded. Of corals the genera *Diploria*, *Meandrina*, *Astrea*, *Siderastrea*, *Porites*, *Isophyllia*, *Oculina* and *Mycedium* were found; of Gorgonians, *Rhipidogorgia* and *Gorgonia*. The Actinaria are very abundant and our collections are numerous. We found but few hydroids and a millespore coral. The Medusæ and Hydro-Medusæ are very abundant in the still waters of Harrington Sound. The Echinoderms are exceedingly interesting and abundant. The Holothuria are represented by the genera *Holothuria*, *Semperia*, *Stichopus*, the last being very abundant. The Asteroidea are few, and are represented by one species of *Asterias* and one of a new genus not yet determined; the Ophiuroidea by several genera. The Echinoidea are represented by *Cidaris*, *Diadema*, *Hipponæ*, *Echinometra*, *Toxopneustes*, *Mellita* and one new genus. The Crustacea are numerous and exceedingly interesting. Our collections will be studied by Dr. Rankin, who will report on them later.

The Mollusca of the archipelago number, according to Heilprin, about 170 marine forms and thirty terrestrial. Among the cephalopoda are *Octopus* and *Argonauta*. The naked *Aplysia* is fairly abundant, and numerous other naked molluscs are found in Harrington Sound.

The Annelids are not as numerous in the places we searched as we expected, but those we found are new to us and the genera are not yet determined. The sponges are very numerous in genera and plenty in individuals. The Tunicates are exceedingly numerous and offer a rich field for investigations. *Amphioxus* is reported, but we had no opportunity to search for it. The abundance and beauty of the Bermuda fishes is notorious. Dr. Bean is making a study of them, carrying on the work started by his colleague the late Dr. G. Brown Goode. Incidental to the main work of the expedition we undertook to furnish the Aquarium in New York with live specimens of some of these fishes, and thousands of visitors to that institution testify to their beauty and gracefulness. This part of the work was by no means the least interesting. We installed four large tanks and a pumping engine on White's Island, in the harbour of Hamilton, and acclimatised the fish before transferring them to the steamship On board the boat the fish were supplied with running water, thanks to the kindness of the Quebec Steamship Company, and no small part of our success was due to the generous and skilful aid given us by the Chief Engineer, Mr. Ritchie. Under these favourable conditions our loss was slight, and another season will be much less. It is interesting to note that our efforts to bring invertebrates alive failed in every

case but one, though we could keep them in prime condition until we struck the polluted waters of the coast, when they died quickly. Our failures, however, have suggested remedies, and next year we hope to show *Octopus*, *Palinurus*, *Ibacus*, *Aplysia* and the sea-anemones, as well as the fishes. The fishes thrive in the Aquarium, although the water is several degrees cooler than they are accustomed to, and the salinity much less. There would be little difficulty apparently in carrying them from New York across the Atlantic, if that were desirable, under the same conditions that we carried them from Bermuda.

Our hasty survey strengthens the idea of establishing a station, and we are planning to have one in working condition by the summer of 1899, if not before. It will have two stories, the lower given up to aquaria, as at Naples, and open to the public during the winter at a small fee; the upper story will be fitted up for a laboratory, and while under the charge of the University will be open to any one competent to carry on an investigation in botany or zoology. It is not intended to rival any of the stations on the Atlantic coast, but to supplement them, and to afford opportunity to investigators of America and Europe to study the flora and fauna of a tropical horizon with ease and comfort. The healthfulness of the place is testified by the yearly visitation of over two thousand guests who spend the winter months there. Malaria is unknown, as is also prostration by heat. The climate during June and July is not disagreeable, the thermometer rarely going up beyond 82° F.

Another project in hand with the station at the Bermudas is the exploration of the West Indies with the Bermudas as a base. Two lines of steamers connect the islands with the West Indies, and the investigator starting on them equipped from the appliances of the station may make a rapid collecting trip to a desired place, and return to work over his material under the more favourable conditions at the station.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The examination for University Mathematical Scholarship and Exhibition will begin on January 20, 1898.

At the Junior Scientific Club on Friday last, November 19, Mr. A. C. Le Rossignol (Exeter) read a paper on "Nitro-explosives." Mr. H. Balfour (Trinity), exhibited a series showing the ancient and modern use of bones of animals as skates. Mr. N. V. Sedgwick (Ch. Ch.) was in the chair.

The regulations for carrying into effect the provisions of the statute relating to the training of teachers are as follows:—I. To obtain the certificate the candidate shall (1) satisfy the authority appointed by the delegates in practical work done under supervision in Oxford; (2) present a record in writing, satisfactory to the delegates, of lessons prepared and given by him, or her, during the training course in Oxford; (3) have taken a further probationary course of teaching in some school appointed by the delegacy; such course to include not less than one hundred lessons, and the report of this work to be signed by the head master or mistress; (4) pay a fee of *2l. 2s.* when the diploma is awarded. II. In the case of candidates already teachers (with the exception of those who shall have passed, or taken honours at, the second public examination after Trinity Term, 1898), the delegacy will certify that a candidate has satisfied them of proficiency in the practice of teaching, provided that the candidate (1) has taught for a year in a secondary school approved by the delegacy; (2) has attended at least one holiday course held under the authority of the delegacy; (3) has satisfied the persons appointed by the delegacy of his, or her, proficiency in the practice of teaching; (4) shall pay a fee of *3l. 3s.*

A HALL of physics, in connection with Syracuse University, will, it is expected, be built next year, the sum of 5000*l.* having already been subscribed for the purpose.

SIR WILLIAM MACCORMAC, the President of the Royal College of Surgeons, England, has been appointed a Governor of the Mason College, Birmingham, for five years.

THE new chemical laboratory building of the University of Berlin, which is at present in course of erection, will, it is stated, contain four large laboratories and twenty-five research rooms, and accommodate 250 students. Its cost will be about 50,000*l.*

AMONG a number of bequests by the late Sir Thomas Elder, of Glan Osmond and Adelaide, South Australia, are:—4000*l.* to Prince Alfred College, Adelaide; 2000*l.* to Way College, Adelaide; 25,000*l.* to Adelaide University; and 20,000*l.* to the Medical School of Adelaide University.

MANUFACTURERS having at heart the advancement of technical education should emulate the action of Messrs. Brunner, Mond, and Co. This firm voluntarily tax themselves to the extent of one penny in the pound on their works at Anderton, Barton, and the rural portion of Winnington, in the interests of technical education in Cheshire.

AT a meeting of the Council of the Royal College of Surgeons, England, on November 11, Felstead School and Watford Endowed Schools were added to the list of recognised places of instruction in chemistry, physics, and practical chemistry; and the South-west London Polytechnic Institute, which was already recognised for instruction in these subjects, was added to the recognised places of instruction in elementary biology.

THE Court of the Drapers' Company have approved the plans of a new building at Oxford, which will be the future home of the Ratcliffe Library if the authorities at Oxford accept them. The cost of the new structure will be 18,500*l.* The Ratcliffe Library was founded by Dr. Ratcliffe considerably over a century ago, but the space it now occupies will be absorbed by the extension of the medical school. The Drapers' Company, in the interests of education, has undertaken to erect the new building, the plans of which have been prepared for the Company by Mr. T. G. Jackson, R.A.

AMONG recent appointments abroad, we notice the following: Dr. Theodore Curtius, of Bonn, to succeed the late Prof. Victor Meyer at Heidelberg; Mr. G. S. Wilkins to be professor of civil and mining engineering at the University of Alabama, and Dr. John Y. Graham to be professor of biology at the same institution; Dr. Max von Frey, of Leipzig, to be professor of physiology at the University of Zürich; Dr. Kraus to be professor of botany at the University of Halle; Dr. Max Dessoir to be associate professor of psychology at the University of Berlin; Dr. Lothar Heffter to be associate professor of mathematics at the University of Bonn; and Dr. Brikencajer to be associate professor of mathematics at the University of Krakau.

THE extent to which County and County Borough Councils in England are working in connection with secondary schools may be seen in a tabular statement published in the current *Record of Technical and Secondary Education*. The tables go to show that during the year 1896–97, sixty-three local authorities gave direct or indirect assistance to three hundred and twenty-eight individual secondary schools to the extent of 144,871*l.*, this sum including the value of scholarships and exhibitions granted for pupils proceeding from secondary schools to higher institutions. Other ways in which the sum referred to was expended were in capitation grants, for teaching staff, maintenance, apparatus, &c., and buildings.

THE Birkbeck Science Society has just been formed in connection with the Birkbeck Institution, London, and purposes holding meetings on the first and third Saturdays of each month, for the reading and discussion of papers on scientific and philosophical subjects. It is also intended to make frequent excursions to places of scientific interest, especially chemical and physical works. It is further intended to publish a journal, containing abstracts of the papers read before the society, together with reports of the scientific excursions. The first meeting of the Society was held on Saturday, in the Chemical Lecture Theatre of the Institution, when a large number of past and present students were present. The Principal of the Institution, Mr. G. Armitage-Smith, occupied the chair, and after welcoming the Society on behalf of the governing body, made some very appropriate and interesting remarks about the value of scientific study. An interesting and instructive paper on "Cavendish and his Work" was then read by Dr. J. E. Mackenzie. The lecturer started by picturing the state of science at the beginning of Cavendish's work, and traced it down to the present day, showing that the 1 per cent. of gas which always remained after his experiments with air, was in reality the argon discovered by Lord Rayleigh and Prof. Ramsay. The Secretary's report was very encouraging, showing

that although the Society had only been in existence for about three weeks, it now numbered more than seventy members. The next meeting of the Society will take place on Saturday, December 4, when Mr. R. S. Clay will deliver an experimental lecture, entitled "Soap Bubbles."

THE opening meeting of the winter session of the General Medical Council was held on Tuesday, Sir William Turner presiding in the absence of Sir Richard Quain, the president. The chairman read a letter from the president expressing regret at the fact that, though his health had improved, he could not undertake the risk of presiding at the meetings during the present session. In the course of his communication Sir R. Quain referred to the progress that had been made with regard to the question of disciplinary or penal powers exercised by the various licensing bodies. Following the example of the University of Cambridge, the University of Durham had now obtained a charter under which it had the power of taking away any degree from a graduate who had been convicted of a crime for which he had been sentenced to penal servitude or imprisonment. Similar steps, he was informed, were being taken by the Victoria University, its court having decided to make application for the necessary amendment of its charter; so that in a very short time that University also would be in possession of extended powers. In Scotland, also, some further steps had been taken in regard to this question. The Universities of Aberdeen and St. Andrews would, no doubt, be prepared to adopt a course of action similar to that taken by Edinburgh and Glasgow. With regard to the new edition of the "British Pharmacopœia," the arduous and important work of preparation that had occupied about three years, was now well nigh finished, and if the Council accepted the draft that would be placed before them in the course of the present session it might be expected that the work would be published at an early date.

SINCE the passing of the Local Taxation Act (1890), twenty-three municipal science and art and technical schools have been established. In a number of localities (states the *Record*) the technical schools have been, or will be, erected as a part of general schemes which include the provision of other institutions for public or municipal use, for example as free libraries, museums, art galleries, gymnasiums, &c. In several localities, on account of the development of the work since the erection of the technical institutions, considerable extensions have been, or are about to be, made to the buildings; the total sum spent or involved for these extensions in the seven districts amounts to over 33,000*l*. In some cases local science and art and technical schools or classes have been transferred to the respective local authorities for municipal management and control since the passing of the Technical Instruction Act, 1889; in Chesterfield the local technical institution, which was erected at a cost of 13,000*l*., was subsequently purchased by the Corporation for the sum of 4000*l*. In Lancaster a splendid institution was built and fitted up and presented to the Corporation by Sir Thomas Storey, and in Northwich and Winsford sites were secured and technical schools were erected and furnished at the expense of Sir Joseph Verdin, Bart. The total amount of money which has been provided by these means for the erection of schools and institutions in seven of these localities (excluding Lancaster) is as much as 81,000*l*., the schools in Burslem, Lancaster, and Southport serving as permanent memorials of Her Majesty the Queen's jubilee of 1887. Excluding Bridgwater and Lancaster, the total sum involved in the erection of technical schools in the thirty-six boroughs and urban districts not included in the above statement is as much as 331,000*l*.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, November.—The rainfall of October, 1897. This was so exceptionally small that all records received up to date showing a total fall of less than an inch for the month have been tabulated. The lowest values, expressed in inches, are found in the extreme south-east of Kent, ·32; Sussex, ·34; Hants, ·49; Essex, ·51; Suffolk, ·59; Surrey, ·60. At least a quarter of the stations quoted, spread over England and Wales, nearly 240 in number, record less than an inch.—Austrian hydrography. This is a summary of the reports of a comparatively new organisation, dealing with the rainfall of the principal watersheds for the year 1895; the stations number between two and three thousand, and the results are contained in fifteen large folio parts. Each part, except the introductory one, includes a large-scale shaded rainfall map, and the whole work probably surpasses anything of the kind in any other country.

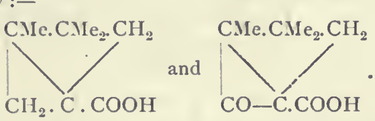
Wiedemann's Annalen der Physik und Chemie, No. 11.—Retardation of spark discharge, by E. Warburg. The period elapsing between the establishment of the necessary difference of potential and the corresponding discharge is called the "retardation." It varies from a few minutes to a fraction of a second, and is due to a non-luminous partial discharge. This preliminary discharge is greatly influenced by ultra-violet light, and also by a magnetic field.—Photo-electric properties of fluorspar and selenium, by G. C. Schmidt. Although fluorspar acquires a positive charge in some parts under the influence of light, and a negative charge in other parts, it only dissipates negative charges under the action of light, and even selenium shows no sign of dissipating a positive charge.—Mutual influence of kathode rays, by J. Bernstein. The apparent repulsion between two kathode beams running side by side is due to some action of the metallic kathode upon the origin of the other beam, and not to any mutual action of projected particles. This may be proved by allowing them to proceed parallel to each other from opposite ends of the tube, when their path remains straight.—On the nature of the salts coloured by kathode rays, by R. Abegg. The coloration of NaCl and KCl salts by kathode rays is not due to the formation of sub-chlorides, since no chlorine is evolved. It is a physical change.—On the carbon electric arc, by R. Herzfeld. The counter E.M.F. produced by the air is not due to the deposition of carbon particles on the kathode, since they may be deflected by a strong electric field without affecting the E.M.F. The growth on the kathode is due to the lack of oxygen necessary for the complete combustion of the carbon.—Conductivity of electrolytes for rapid oscillations, by J. A. Erskine. An oscillator is placed in a basin filled with petroleum, and another dish containing the resonator immersed in the electrolyte is placed on the top of it. The electric resistance of the electrolyte is directly proportional to the thickness required to produce a given amount of damping.—Absorption of electric oscillations by luminescent gases, by E. Wiedemann and G. C. Schmidt. Gases excited to luminescence in a vacuum tube screen other tubes from similar excitation, but flames do not, neither does the dark kathode space. A similar screening is produced by Goldstein's "canal rays."

Meteorologische Zeitschrift, October.—Some results of the five years' observations on the Eiffel Tower, by A. Woeikof. The author compares the daily periods of temperature and wind force for certain selected months; in the winter the minimum wind force at the summit of the tower occurs about the time of the highest daily temperature; while in summer it takes place considerably earlier, about 9h. or 10h. The force then increases gradually until the time of highest temperature, and afterwards more rapidly, until evening. The times of the maxima at the summit and on the ground do not exhibit any decided seasonal range, but in the case of the minima a seasonal range is clearly shown. During May to July the mean time is 1·3 hours earlier than during November to February. At the summit the occurrence of the minimum is earlier in summer than in winter, and the interval is greater, viz. 4·5 hours. An explanation of these phenomena is suggested by Dr. Woeikof.—The total variation of temperature in the Arctic and Equatorial oceanic climate, by A. Woeikof. The variations considered are those shown by hourly observations for certain representative months for Batavia and Sagastyr (mouth of the Lena). Dr. Woeikof finds that summer and spring have nearly the same variation in the Equatorial and Arctic climate, and that the uniformity of summer temperature in polar regions is exhibited by this investigation. The total variation is even somewhat smaller than at Batavia, while the non-periodic portion is not twice as great.—Dr. W. Trabert contributes an article on the extraordinary rainfall in Austria between July 26 and 31 last, which caused destructive floods in several districts.—Among the smaller notices, Prof. G. Hellmann gives a formula for the conversion of Fahrenheit to Centigrade degrees, which is simpler than that usually employed, viz.: to half the difference between the reading and 32° add the tenth and hundredth part of this difference, *e.g.* $\frac{74-32}{2} = 21 + 2{\cdot}1 + {\cdot}2 = 23^\circ{\cdot}3$, the value given in the tables. For an explanation of the rule we refer our readers to the original notice.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, November 4.—Prof. Dewar, President, in the chair. The following papers were read :—On the properties of liquid fluorine, by Profs. Moissan and Dewar (see page 82).—The liquefaction of air and the detection of impurities, by Prof. Dewar. The author has devised an apparatus for ascertaining the proportion of any gas in air that is not condensible at about $-210°$ C. under atmosphere pressure, or is not soluble in the liquid air produced ; the air to be examined is cooled in a tube immersed in a reservoir, which can be continuously replenished with liquid air boiling under diminished pressure. The gas which does not condense under these conditions can be subsequently collected and examined, or the liquefied portion of the air can be boiled in the condensing tube and the gas collected over mercury. On thus condensing 70 litres of the gas issuing from the King's Well at Bath, which Rayleigh has shown to contain 0·12 per cent. of helium by volume, a liquid was obtained which, when boiled, gave off first a gas containing about 50 per cent. of helium. It is concluded that helium is less soluble in liquid nitrogen than hydrogen is in liquid air, and that by proceeding as above helium can be separated from a gas in which it is present to the extent of only one part per thousand ; it would seem, further, that hydrogen and helium have about the same volatility.—The absorption of hydrogen by palladium at high temperatures and pressures, by Prof. Dewar. The author, after summarising his previous work on the absorption of hydrogen by palladium, describes experiments made with the object of ascertaining whether the metal absorbs the gas at high temperatures and pressures ; palladium does not absorb hydrogen under atmospheric pressures at above 145° C. A rod of palladium, weighing 119 grams, and occupying 10 c.c., was placed in a gas-tight steel cylinder, connected with a manometer, a compressed hydrogen cylinder, and a blow-off cock ; the vessel containing the palladium could be heated in a bath of fusible metal. It was found that the palladium absorbed over 300 times its volume of hydrogen at 420° under 80 atmospheres pressure, whilst it absorbed 300 times its volume of the gas at 500° under 120 atmospheres. The experiments have led to the deduction of a number of interesting thermal constants for the absorbed hydrogen.—On some yellow vegetable colouring matters, by A. G. Perkin. The *Rhus rhodanthema*, a tree indigenous to New South Wales, contains fisetin, $C_{15}H_{10}O_6$, and a glucoside of fisetin, $C_{36}H_{30}O_{16}$ resembling fustin, the fisetin glucoside present in *R. cotinus*.—Naphthylureas, by G. Young and E. Clark. The mononaphthylureas may be prepared by treating the naphthylamine hydrochlorides with potassium cyanate, and readily become converted into the symmetrical dinaphthylureas. — Benzoylphenylsemicarbazide, preliminary notice, by G. Young and H. Annable. Benzoylphenylsemicarbazide exists in three different forms, melting at 202–203°, 205–206°, and 210–211° respectively.—Sulphocamphylic acid, by W. H. Perkin, jun. From the results of an investigation of sulphocamphylic acid, the author assigns the following probable constitutions to isolauronolic and isolauronic acid respectively :—



Geological Society, November 3.—Dr. Henry Hicks, F.R.S., President, in the chair.—The Secretary announced that Lady Prestwich had presented to the Society a half-length portrait in oils of the late Sir Joseph Prestwich, painted by Mr. W. E. Miller.—Mr. W. W. Watts gave details of some interesting geological features recently exposed at the new sewerage works at Carshalton, Surrey, now being made by the Urban District Council. These excavations are situated at a spot which on the Geological Survey map is coloured as London clay ; and the features of the ground fully justified this colouring. The excavations, however, have shown that there are loamy and sandy beds of a light yellow colour, some 14 or 15 feet in thickness, and apparently occupying a hollow in the London clay. At the base these sandy beds become dark and clayey in some places, and include flints and pebbles, while below this is the London clay. In the dark pebbly layer were found a large skull, a piece of a tusk, and a number of smaller bones, which Mr. E. T. Newton has determined to be a piece of elephant-tusk, the skull (31 inches long) of *Rhinoceros antiquitatis* with some of its limb-bones ; while the smaller bones represent two or perhaps three horses. Although the teeth of the rhinoceros are wanting, the skull is otherwise very perfect ; and, bearing this in mind, as well as the fact that certain of the limb-bones were also found, and that *Elephas* is represented by the tusk, and all three (it is said) at a depth of 14 or 15 feet, little room is left for doubting that we have here at Carshalton a Pleistocene deposit of a somewhat unusual character, and at a spot where it was not before suspected. Mr. Whitaker, who was responsible for the geological mapping of this district, pointed out how the general configuration of the district gave no clue to the presence of this deposit of loamy sand, which occurred on a gentle slope, and that even now it was only possible to mark it on the map as an oval patch round the excavations with uncertain boundaries. The drift shown, moreover, differs from that of the neighbourhood in that the latter is essentially gravel, while the former is sand, with loamy beds, but, as a rule, not stony, so that there are no surface-indications of gravel. The mammalian remains are now preserved in the Museum of Practical Geology.—Lieut.-General McMahon having taken the chair, the President made a communication regarding very similar deposits to those above described occurring in north-western Middlesex. Some years ago he described sections in glacial drift on the Hendon plateau exposed during sewerage operations. More recently the sewers have been carried on at lower levels between Hendon and Edgware, and numerous remains of the mammoth and rhinoceros have been found resting on an eroded surface of London clay, and covered over by about 7 feet of stratified sands and gravels and brick-earth. These deposits were found to spread out for considerable distances over the plain, and to be cut through also by the Silke stream, a tributary of the Brent. This area has hitherto been supposed to consist almost entirely of London clay, but the sections have now shown that the brick-earth which, in many respects, simulates the London clay, is underlain by deposits which must be classed as of Pleistocene age.—The President then resumed the chair, and Mr. H. B. Woodward called attention to a block of quartzite from Criccieth in Carnarvonshire, which had been sent for exhibition by Mr. G. J. Day. The rock contained a band of disrupted clayey material which presented on the surface of the block a rude resemblance to hieroglyphics. He thought that the curious structure had been produced on a sea-shore bounded by clay cliffs, where a film of mud had been spread over the sands ; and that the mud had dried and curled up before other layers of sand had been accumulated on the top of it. Similar phenomena might be produced at the present day on the Cromer coast, where thin films of mud were in places spread over the sands of the sea-shore. It had been suggested that the appearances in the Criccieth stone might have been produced in the original deposit during the irregular solidification of the sand and its included layer of mud. The rock itself was regarded by the President as probably derived from the Harlech grits, in which he had observed somewhat similar features.—Mr. Bauerman, as one of the three delegates appointed by the Council on behalf of the Society to attend the recent International Geological Congress, held at St. Petersburg, gave a short account of the work of the Congress, dwelling more particularly on the excursion to the Ural Mountains, in which he had taken part.—The following communication was read : A contribution to the palæontology of the decapod Crustacea of England, by the late James Carter. This paper deals mainly with the Brachyura. The author describes several new species belonging to the genera *Nephrops*, *Gebia*, *Homolopsis*, *Ranina*, *Mithracia*, *Neptunus*, *Actæopsis*, and *Goniocypoda*. The genera *Gebia*, *Ranina*, and *Neptunus* have not been previously recorded from British rocks. *Diaulax* is for the first time identified from the Tertiary strata, a single specimen having been found in the Middle Headon. *Platypodia Oweni*, Bell, is now referred to the genus *Diaulax* ; and *Palæocorystes Broderipi*, Bell, to the genus *Eucorystes*. As a result of the careful study of large series of specimens in various collections, the author is able to give much additional information concerning the morphology of several species.

Zoological Society, November 16.—Dr. Albert Günther, F.R.S., Vice-President in the chair.—The Secretary read some notes, made by Mr. A. Thomson, Head-Keeper, on the breeding of two species of Glossy Ibis (*Plegadis guarauna* and *P. falcinellus*) in the Society's Gardens, and made remarks on the differences in their plumages. The Secretary also exhibited an

egg of the Brazilian Cariama (*Cariama cristata*), laid in the Society's Gardens, and read some notes made by Mr. A. Thomson, Head-Keeper, on the breeding of this bird.—Mr. Sclater gave an account of some of the more interesting animals observed by him during a recent visit to the Zoological Gardens of Cologne, St. Petersburg, Moscow and Berlin.—A note was read from Messrs. Oldfield Thomas and R. Lydekker, stating that during the preparation of their paper on the dentition of the Manatee, published in the last part of the *Proceedings*, an important memoir by Dr. C. Hartlaub on the subject, in which some of their conclusions had been anticipated, had been overlooked.—Mr. R. Lydekker, F.R.S., exhibited a skin of the Blue Bear of Tibet (*Ursus pruinosus*), described and figured in the Society's *Proceedings* (*P. Z. S.*, 1897, p. 412, pl. xxvii.), and a sketch of the Altai Deer (*Cervus eustephanus*) taken from a specimen in the menagerie of the Duke of Bedford at Woburn Abbey.—A communication by Mr. George P. Mudge, "On the Myology of the Tongue of Parrots," was read by the author. Specimens of six different species of the *Psittacidæ* had been examined, and a detailed description of the muscles of each of them was given in this paper.—A communication from Mr. E. T. Browne, "On British Medusæ," was read. It was a continuation of a previous paper, entitled "On British Hydroids and Medusæ," published in the *Proceedings* for 1896. Eight species were treated of at length.—Dr. A. G. Butler enumerated the species (138 in number) contained in three consignments of butterflies collected in Natal in 1896 and 1897 by Mr. Guy A. K. Marshall, and gave the dates of the capture of the specimens, the localities where they were found, and other interesting notes concerning them. One new genus (*Chrysoritis*) and one new species (*Cacyreus marshalli*) were described. A communication from Mr. Edgar R. Waite, of the Australian Museum, Sydney, "On the Sydney Bush-Rat (*Mus arboricola*, W. S. Macleay)," was read. It treated of the habits of the animal in a wild state and of its anatomical characters.—A third portion of a paper on the spiders of the Island of St. Vincent, by M. E. Simon, was communicated by Dr. D. Sharpe, F.R.S., on behalf of the committee for investigating the fauna and flora of the West Indian Islands. Of the species enumerated forty-six were described as new, which included three new genera, viz. *Mysmenopsis*, *Homalometa*, and *Mesobria*.—Prof. Alfred Newton, F.R.S., exhibited some specimens of new or rare birds' eggs, and read some notes upon them. Amongst these were the first properly authenticated examples of the eggs of the Curlew-Sandpiper (*Tringa subarquata*) obtained by Mr. Popham on an island in the mouth of the Jenisei River in July last. Other eggs exhibited were those of *Turdus varius*, *Chasiempis sandvicensis*, *Himatione virens*, *Emberiza rustica*, and *Podoces panderi*.

Linnean Society, November 4.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. F. G. Jackson, leader of the Jackson-Harmsworth Polar expedition, exhibited a series of lantern-slides, illustrating some zoological observations of the expedition, the most noteworthy being views of the hibernaculum of the polar bear and of the breeding haunts in Franz Josef Land of the ivory gull (*Pagophila eburnea*), the eggs of which were also shown.—Mr. H. Fisher, botanist of the expedition, brought for exhibition a collection of plants made by him in Franz Josef Land, the consideration of which was deferred for want of time.—Mr. Reginald Lodge exhibited some lantern-slides of marsh birds, their nests, eggs, and young, from photographs recently taken in Spain and Holland.—Sir John Lubbock, Bart., M.P., read a paper on the attraction of flowers for insects, which dealt chiefly with the points raised in three recently published memoirs by Prof. Plateau, who had attempted to show that the scents and not the colours of flowers serve to attract insects. Sir John Lubbock explained that his view, like that of Sprengel and Darwin, was that to insects flowers were indebted for both their scent and colour. Not only had the present shapes and outlines, colours, the scent, and the honey of flowers been gradually developed through the unconscious selection exercised by insects, but this applied even to minor points, such as the arrangement of lines, and the different shades of colour. Prof. Plateau had recorded a series of experiments on the dahlia, in which he showed that bees come to these flowers even when the ray-florets have been removed. Discussing this point, Sir J. Lubbock said it was somewhat singular that he should have selected as proving that insects are entirely attracted by scent a flower which had, so far as he knew, no scent at all. He gave several reasons for disputing the conclusions drawn by Prof. Plateau from his experiments, and recorded others made by himself which refuted them. He had selected species of flowers in which the scent is in one part and the coloured leaves in another, as, for instance, the *Eryngium amethystinum*. This flower is surrounded by brilliant blue bracts; and he found that if the two parts were separated, the bees came more often to the bracts than they did to the flowers themselves. He maintained, therefore, that the observations of Prof. Plateau did not in any way weaken the conclusions which had been drawn by Sprengel, Darwin, and others, and that it was still clear that the colours of flowers serve to guide insects to the honey, and in this way secure cross-fertilisation.—Mr. W. C. Worsdell communicated a paper on transfusion-tissue, its origin and functions in the leaves of Gymnospermous plants.

PARIS.

Academy of Sciences, November 15.—M. A. Chatin in the chair.—Reaction of hydrogen upon sulphuric acid, by M. Berthelot. Sulphuric acid absorbs hydrogen completely at 250°, and even in the cold, during two months, 75 per cent. of the hydrogen present was absorbed, with production of a corresponding amount of sulphur dioxide. This reaction does not take place with the diluted acid. A thermo-chemical study shows that the dilution of the acid changes the thermal sign of the reaction.—Influence of oxygen upon the decomposition of the hydracids by metals, and especially by mercury, by M. Berthelot. Although pure hydrogen chloride may be kept over mercury for several years without change, in the presence of oxygen there is a slow absorption, as a result of which the acid is wholly absorbed according to the equation

$$4HCl + O_2 + 4Hg = 2Hg_2Cl_2 + 2H_2O.$$

A similar reaction takes place between mercury, hydrogen sulphide, and oxygen. In both these cases there is an evolution of heat during the reaction.—Direct action of sulphuric acid upon mercury at the ordinary temperature, by M. Berthelot. Mercurous sulphate and sulphur dioxide are produced after long standing at ordinary temperatures.—Observations on the swarm of shooting stars, made at the Observatory of Paris, during the nights of November 13–14, 14–15, 1897, by M. Lœwy.—Influence of surfusion upon the freezing point of solutions of potassium chloride and sugar, by M. F. M. Raoult. The experiments quoted now definitely show that the molecular lowering of the freezing points for potassium chloride and sugar have limiting values agreeing with the predictions of Arrhenius.—On the integration of the equations of heat, by M. Le Roy.—Observations of the shooting stars at the Observatory of Meudon, by M. Hansky.—Observations on this communication, by M. J. Janssen.—The mechanical principles involved in the practical application of the mercury bath as a means of obtaining a true vertical, at the Paris Observatory, by M. Maurice Hamy.—On a generalised displacement in which all points describe spherical trajectories, by M. Ernest Duporcq.—On the theory of complete functions, by M. Erik Schou.—On the transmission of energy at a distance. Application to rotatory polarisation, by M. André Broca.—On the coefficients of expansion of gases, by M. A. Leduc. From the experimental results on the densities of gases previously given, a formula is derived for the true coefficient of expansion at 0° C. under a pressure of π cm. of mercury. This formula is applied to some twenty-three gases, and the figures obtained compared with the experimental results of M. P. Chappuis.—Action of water upon phosphorus trichloride, by M. A. Besson. Evidence is adduced of the existence of a phosphorus oxychloride, POCl, analogous to NOCl. It is formed by the action of a small quantity of water upon an excess of phosphorus trichloride, according to the equation

$$PCl_3 + H_2O = 2HCl + POCl,$$

and is separated from the excess of the trichloride, by distillation in a vacuum. POCl forms a waxy solid, of the consistence of paraffin, which is insoluble except in PCl_3. The yield is very small, never exceeding 0·2 to 0·5 gr. per kilogram of PCl_3 used.—On cerium, by M. O. Boudouard. By fractional crystallisation and precipitation of the acetate and sulphate of cerium it is found that cerium oxide is contaminated with small quantities of another earth possessing a lower atomic weight.—On the preparation of strontium sulphide by means of hydrogen sulphide and strontia or strontium carbonate. Influence of temperature,

by M. José Rodriguez Mourelo.—Production of volatile fatty acids from the waters used in the *désuintage* of wool, by MM. A. and P. Buisine. The acids obtained include acetic, propionic, butyric, valerianic, and caproic, the two first belng the chief constituents.—On the decomposition of chloroform, bromoform, and choral by aqueous potash, by M. A. Desgrez. An aqueous solution of potash attacks chloroform slowly, with production of carbon monoxide. Light hastens the reaction. Bromoform behaves similarly, except that being much less soluble in water than chloroform, the action is less. Iodoform is not affected under the same conditions.—On silver cyanamide, by M. Paul Lemoult. A thermo-chemical paper.—Observations on the crabs of the family of the Dorippidia, by M. E. L. Bouvier. A contribution to the study of the evolution of the deep-sea crabs. The close analogy between the species found in West Indian seas and the Eastern Pacific leads to the conclusion that at no very distant period the oceans were connected at Panama.—On a new type (*Metchnikovella*) of organisms parasitic to *G. spionis*, Köll, by MM. Maurice Caullery and Félix Mesnil.—On a bacterium pathogenic for Phylloxera and for certain Acarians, by M. L. Dubois.—On the determination of sex in hemp, by M. Molliard. From a fixed number of hemp seeds, an alteration of the conditions of growth may cause an alteration in the proportion of male and female plants produced.—Action of mineral salts upon the form and structure of the lupin, by M. Dassonville. The presence of dissolved salts, among other effects, increases the number and diameter of the vessels, and retards lignification in all the organs of the lupin.—On the composition of the oat, by M. Olivier de Rawton.—Composition of buck-wheat, by M. Balland.—On the use of calcium carbide against black rot, by M. G. Rodier.

NEW SOUTH WALES.

Linnean Society, September 29.—Dr. J. C. Cox, Vice-President, in the chair.—Revision of the Australian *Curculionidæ* belonging to the subfamily *Cryptorhynchides*, Part i., by Arthur M. Lea. The subfamily *Cryptorhynchides* being in considerable confusion, it is proposed to examine and redescribe all the Australian genera and species referred to it. The genus *Poropterus* is treated of in the present communication, seventeen species being described as new.—On a new species of *Eucalyptus* from the Sydney district, by Henry Deane and J. H. Maiden. This is a tree of about thirty feet in height, with scaly bark and red timber. The seedling-leaves are ovate to ovate-lanceolate and always alternate. The veins and midribs are reddish and conspicuous. The transverse veins are numerous and fine, making an angle with the midrib of about 50°. The fruits are nearly hemispherical, with a slight tendency to constriction of the orifice, about four lines long by three lines deep, with a sunk rim. The anthers open by pores, showing the affinity of the species, in this direction, to *E. hemiphloia*, and the "Boxes." Its bark bears a superficial resemblance to that of *E. corymbosa*, and, because of its scaly nature, the name of *E. squamosa* is proposed for it.—Descriptions of some new Araneidæ of New South Wales, No. 8, by W. J. Rainbow. Ten new species are described and figured, of which four are referable to the genus *Epeira*, three to *Argiope*, and one each to *Dicrostichus*, *Cheiracanthium*, and *Attus*. In addition to these, numerous specimens of architecture of spiders are described, and some figured, the families illustrated being the *Epeiridæ*, *Drassidæ*, *Attidæ*, and *Thomisidæ*.—Note on the genus *Aphritis*, Cuv. and Val., by J. Douglas Ogilby. The author contends that whereas five different fishes have been assigned to the genus *Aphritis*, C. and V., by various authors, these are referable to but three distinct species, each of which represents a monotypic genus; he distributes them as follows: *A. porosus* and *A. undulatus* lege *Eleginops maclovinus* (C. and V.), Gili; *A. urvillii* and *A. bassii* lege *Pseudaphritis urvillii* (C. and V.); *A. gobio*, Gnth., differs greatly from *Pseudaphritis*, and must receive a new generic name. He concludes by suggesting that *Eleginus bursinus*, C. and V., is identical with *P. urvillii*, in which case our species would have to be called *Pseudaphritis bursinus*.—Notes on the species of *Cypræa* inhabiting the shores of Tasmania, by C. E. Beddome.

AMSTERDAM.

Royal Academy of Sciences, September 25.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Hoek on the results of an inquiry, made by order of Government, into the practice of fishing with so-called "ankerkuilen" (large tow-nets not unlike those employed in the Thames estuary for the whitebait-fishing), used in close time (April 1–June 15), in the mouth of the river, just below the limit of the farmed-out part, particularly with regard to our knowledge of the habits of the salmon, its migrations, &c.—Prof. Suringar presented a fifth contribution to the knowledge of the Melocacti, as a sequel to previous papers. The author showed the skeleton and a photograph of a specimen of *Melocactus humili* from Venezuela, described by himself in 1889, and seeds of which he sent at the time to the firm of Damman and Co., near Naples. It seems that the culture of this plant, which does not succeed in hothouses in North and Middle Europe, might be tried with advantage in the sunny climate of the South Italian coast, exposed to sea-winds. Prof. Suringar exhibited a live specimen, now seven years old, raised from the seed by the above firm, and which has already blossomed and borne fruit. With the exception of a slight difference in size and shape, the mother- and the daughter-plant are very similar. In the colony itself, too, the culture will be tried, that it may be possible to send culturable specimens over from there without detriment to the natural flora. The author exhibited photographs and gave a description of five new genera, received from Curaçao. The berries of these specimens, which have developed themselves on the plants in tolerably large numbers after the arrival of the latter, will be sent back to the colony, together with those of some known genera, received at the same time and determined in Amsterdam, to be sown there, so that the seedlings will at once go by their right names. In conclusion the author presented for inspection the first part of the Iconography announced some time back and published by the firm of E. J. Brill at Leyden, as the third volume of the "Musée Botanique" and entitled "Illustrations de Melocactus," with reproductions of photographs and coloured plates of the thorns, flowers and fruits.—Prof. Lorentz on the partial polarisation of the light emitted by a source in a magnetic field. The author showed how this phenomenon (discovered by Egoroff and Gorgiewsky) may be explained by taking into account the absorption which the rays of one part of the flame undergo in the other, this absorption being modified when the periods of the vibrations are changed by the Zeeman effect. In support of this view the author described an experiment in which the light of a sodium-flame which is placed outside the field, is found to be partially polarised after it has passed through a similar flame standing between the poles.—Prof. van der Waals on the graphic representation of equilibriums by means of the ζ-function. The author observed that at a given pressure and temperature, ζ has three values, and that consequently in general a surface is obtained, consisting of three sheets. Coexisting equilibriums exist if a common tangent plane to points either of the same sheet or of different sheets is possible. Increased pressure causes the heterogeneous region to decrease if the mixing is accompanied by contraction, and conversely. Similarly a rise of temperature causes the heterogeneous region to decrease if a supply of heat is required for the mixing, and conversely.—Prof. Behrens read a paper on mixture crystals of $KMnO_4$ with $KClO_4$ and of Ag_2CrO_4 with Ag_2SO_4, which may serve to prove the presence of perchloric and chromic acid. That these crystals are not discoloured by saturated solutions of $KClO_4$ and of Ag_2SO_4, must not be explained by assuming the crystals to be impenetrable, as enclosures are dissolved under similar circumstances.—Prof. Behrens also dealt with micro-reactions of free sulphuric acid, free ammonia and free alkalis. The first is owing to the formation of quinineherapatheite, the second to the formation of palladoammonium chloride. To detect KOH and NaOH together, the solubility of $PbCrO_4$ in caustic alkalis may be made use of; if they are to be separated at the same time, niobic acid hydrate is the best reagent. With KOH it yields a transparent solution, with NaOH colourless needles and rods. Antimonic acid hydrate too easily forms difficultly soluble salts with KOH.—Prof. Martin read a paper on the geology of the Moluccas, in connection with a work published by himself, supported by Government, and entitled "Reisen in den Molukken, in Ambon, den Uliassern, Seran (Ceram) und Buru, Geologischer Teil." A large portion of Ambon is of volcanic origin, and contains the continuation of the chain of volcanoes in Halmahera; Wawani in Ambon had an eruption as late as 1674. On the other hand, Wallace's opinion that Buru and the north-western part of Seran (Ceram) are volcanic, is incorrect. The author ascribed the eruptions in Halmahera, Ternate and Ambon to lateral displacements in the earth's crust, for in the most recent geological part terrific elevations took place; in Ambon, for

instance, the new reef chalks are situated as high as 480 m. above the sea-level. Volcanic eruptions and elevations are evidently intimately connected in those regions.—Prof. van der Waals presented on behalf of Dr. D. F. Tollenaar, for publication in the *Proceedings*, a paper on "Deflection and reflection with two kathodes." The phenomena occurring when two kathodes are used, and which were described in a previous paper, may be explained in a simple way if the kathode rays are assumed to consist of negatively-charged particles, which are emitted with great velocity. Adopting Schuster's formula for the potential fall in the proximity of a kathode, the course of such a particle, near a kathode, can be calculated. In this way the following results are arrived at: (1) behind the deflecting kathode the kathode rays cut each other, and so give rise to a surrounding sheet of light; (2) if the two kathodes emit their rays towards each other, then the rays of one kathode are partly so strongly deflected by those of the other as to be reflected to the emitting kathode; (3) with each of the two kathodes these reflected rays give rise to a second enclosing sheet of light and a corresponding deflection figure; (4) if the two kathodes are made to be of different intensity, the sheet of deflection formed by these reflected rays becomes larger towards the less intense kathode. This sheet of deflection, however, is not an ordinary Goldstein macro-surface, but might be called a pseudo macro-surface.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 25.

ROYAL SOCIETY, at 4.30.—On the Geometrical Treatment of the "Normal Curve" of Statistics, with especial reference to Correlation, and to the Theory of Error: W. F. Sheppard.—Mathematical Contributions to the Theory of Evolution. IV. On the Probable Errors of Frequency Constants, and on the Influence of Random Selection on Variation and Correlation: Prof. K. Pearson, F.R.S., and L. N. G. Filon.—On Certain Natural Media for the Cultivation of the Bacillus of Tubercle: Dr. A. Ransome, F.R.S.—Further Note on the Transplantation and Growth of Mammalian Ova within a Uterine Foster-mother: Walter Heape.—Further Observations upon the Comparative Physiology of the Suprarenal Capsules: Swale Vincent.—Summary of Prof. Edgeworth David's Preliminary Report on the Boring at Funafuti: Prof. T. G. Bonney, F.R.S.—On the Determination of the Indices of Refraction of Various Substances for the Electric Ray. II. Index of Refraction of Glass: Prof. J. C. Bose.—On the Influence of the Thickness of Air-Space on Total Reflection of Electric Radiation: Prof. J. C. Bose.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Accumulator Traction on Rails and Ordinary Roads: L. Epstein. (Continuation of Discussion.)

CAMERA CLUB, at 8.15.—Photographic Action writ large: a Kurvey-linear Conversation on Corn: Prof. Armstrong, F.R.S.

LONDON INSTITUTON, at 6.—Acetylene: Prof. Vivian Lewes.

FRIDAY, NOVEMBER 26.

PHYSICAL SOCIETY, at 5.—Upon the Failure of German Silver and Platinoid Wires: Rollo Appleyard.

SATURDAY, NOVEMBER 27.

ESSEX FIELD CLUB (at Buckhurst Hill), at 7.—The Entomostraca of Epping Forest: D. J. Scourfield.—Report on Conference of Delegates of Corresponding Societies at Toronto: Prof. R. Meldola, F.R.S.

MONDAY, NOVEMBER 29.

SOCIETY OF ARTS, at 8.—Gutta-Percha: Dr. Eugene F. A. Obach.

IMPERIAL INSTITUTE, at 8.30.—Kafiristan: Sir George S. Robertson.

INSTITUTE OF ACTUARIES, at 5.30.—Address by the President.

TUESDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

ZOOLOGICAL SOCIETY, at 8.30.—On Regeneration of the Legs in the *Blattidæ*: H. H. Brindley.—On a Gigantic Sea-Perch (*Stereolepis gigas*): G. A. Boulenger, F.R.S.—Description of a New Tortoise of the Genus *Sternothærus*: G. A. Boulenger, F.R.S.—Remarks upon a Mountain Reedbuck from the Eastern Transvaal: F. V. Kirby.

INSTITUTION OF CIVIL ENGINEERS, at 8.—On the Law of Condensation of Steam: Hugh L. Callendar, F.R.S., and John T. Nicolson.

WEDNESDAY, DECEMBER 1.

SOCIETY OF ARTS, at 8.—The American Bicycle—the Theory and Practice of its Making: Dr. Leonard Waldo.

GEOLOGICAL SOCIETY, at 8.—A Revindication of the Llanberis Unconformity: Rev. J. F. Blake.—The Geology of Lambay Island, Co. Dublin: C. I. Gardiner and S. H. Reynolds.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, DECEMBER 2.

LINNEAN SOCIETY, at 8.—On the Anatomy of *Caudina coriacea*: Prof. Arthur Dendy.—On some Desmids from the United States: W. West and G. S. West.——Exhibitions: Specimens of Galls of *Cecidomya*: Prof. J. B. Farmer.—An Egg of *Echidna*: Martin Woodward.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—On Collie's Space-Formula for Benzene: Dr. F. E. Matthews.

CAMERA CLUB, at 8.15.—Photomicrography: Dr. Spitta.

FRIDAY, DECEMBER 3.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Permanent Way: its Construction and Relaying: Grote Stirling.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Agricultural Chemistry: R. H. Adie and T. B. Wood, 2 vols. (K. Paul).—La Face de laTerre: Prof. E. Suess; traduit E. de Margerie, Tome 1 (Paris. Colin).—Leitfaden für Aquarien-und Terrarienfreunde: Dr. E. Zernecke (Berlin, Schmidt).—Die Moorbrücken im Thal der Sorge auf den Grenze Zwischen Westpreussen und Ostpreussen: H. Conwentz (Danzig, Bertling).—The Story of a Red Deer: Hon. J. W. Fortescue (Macmillan).—The Gallinaceous Game Birds of North America: D. G. Elliot (Suckling).—Practical Forestry: Prof. C. E. Curtis, 2nd edition (Lockwood).—The Hope Reports: edited by Prof. Poulton, Vol. 1 (Oxford).—Recherches Experimentales sur quelques Actinomètres Electro-chimiques: Dr. H. Rigollot (Paris, Masson).—Le Culture des Mers en Europe: G. Roché (Paris, Alcan)—Sixteenth Annual Report of the Bureau of American Ethnology (Washington).—The Foundations of Scientific Agriculture: Prof. S. Cooke (Longmans).—A Text-Book of General Botany: Dr. C. C. Curtis (Longmans).—With Nature and a Camera: R. Kearton (Cassell).—La Tuberculose et son traitement hygiénique: P. Merklen (Paris, Alcan).—Pflanzenphysiologie: Dr. W. Pfeffer, Zweite Auflage i. Band (Leipzig, Engelmann).—Kollektivmasslehre: G. T. Fechner, herausgegeben von G. F. Lipps (Leipzig, Engelmann).—Tafeln und Tabellen zur Darstellung der Ergebnisse Spectroskopischer und Spectrophotometrischer Beobachtungen: Prof. T. W. Engelmann (Leipzig, Engelmann).—Observations on the Coloration of Insects: B. von Wattenwyl, translated by E. J. Bles (Leipzig, Engelmann).—Bescbreibung der Hauptmethoden welche bei der Bestimmung der Verbrennungswärme: W. Longuinine (Berlin, Friedländer).—Elementary Drawing; E. M. Hallowell (Macmillan).—Zoological Record, 1896 (Gurney).—First Book of Physical Geography: Prof. R. S. Tarr (Macmillan).—Compositions d'Analyse, Cinématique, Mécanique et Astronomie: Prof. E. Villié, troisième partie (Paris, Gauthier-Villars).—Laboratory Tables for Qualitative Analysis, 2nd edition (Manchester, J. E. Cornish).

PAMPHLETS.—Das Wachstum des Menschen: Dr. F. Daffnfr (Leipzig, Engelmann).—Observations on a Collection of Papuan Crania: G. A. Dorsey (Chicago).—A Discussion of the Rainfall of South Africa during the Ten Years 1885–94: Dr. A. Bucban (Cape Town).

SERIALS.—Journal of the Franklin Institute, November (Philadelphia).—Science Progress, October (Scientific Press).—Journal of the Academy of Natural Sciences of Philadelphia, 2nd edition, Vol. xi. Part 1 (Philadelphia).—Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg, 1896 October-December, 1897 April-June (St. Pétersbourg).—Chambers's Journal, Cbristmas (Chambers).—Himmel und Erde, November (Berlin).

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THURSDAY, DECEMBER 2, 1897.

TEA.

A Text-Book of Tea Planting and Manufacture. By David Crole. Pp. xii + 242. (London: Crosby Lockwood and Son, 1897.)

THIS handsomely got-up book, although written with too obvious a bias in favour of the produce of India and Ceylon, as distinguished from that of China, is a valuable contribution to the literature of an important subject. Mr. Crole's experience has been mainly gained in the "gardens" and "houses" of Assam, but he has evidently had good opportunities of acquiring information from personal observation of the methods of cultivation and manufacture in other parts of our East Indian possessions. Of China he apparently knows nothing from personal experience, and the value of his strictures on the character of the produce, as well as of the modes of manufacture, of the Celestial Empire may be said to suffer in consequence. The book is mainly written for the benefit of planters, but there is much in it of interest to the general reader who is not insusceptible to the charms of "the sovereign drink of pleasure and of health." The extraordinary growth in the consumption of tea in Great Britain is a significant feature in our social and domestic economy. As it is the fashion just now to compare everything at present with what it was in 1837, it may be interesting to note that whereas in that year the amount of tea consumed in this country did not exceed 30,000,000 lbs., all of which came from China, the quantity now imported is upwards of 230,000,000 lbs., or more than 5¾ lbs. per head of population. China now furnishes less than half the amount she sent into this country at the time of the Queen's accession. The import from India, which began in the early 'sixties, now amounts to more than five times that from China; whilst Ceylon, which has only sent tea into this country to any extent during the last fifteen years, furnishes us with more than three times the quantity of that from China. In other words, China now sends us only about 10 per cent. of our tea, whereas ten years ago she gave us half the amount we then consumed. It is obvious, therefore, that unless China can be induced to abandon her absurdly exclusive policy, her tea trade with and through this country is doomed.

As is well known, Chinese tea is mainly made from the *Thea chinensis*, whilst that from India is the produce of *T. assamica*. Mr. Crole calls the former variety "a poor, scrubby-looking shrub" and "a wretched plant." From his remarks it would appear that the only service that Fortune rendered to the Indian tea industry by the introduction of the Chinese plant was the deterioration of the indigenous seed, giving rise to quantities of hybrids of various qualities, "from very rank stuff to fairly good." According to the author, the most that can be said in favour of the China plant is that it is distinctly more hardy than the Assam variety. We are disposed to believe that Mr. Crole's prejudices affect his judgment. There is no question whatever that some of the finest and most wholesome tea the world produces is to be met with in China. Whether it is to be met with in this country is wholly a question of price.

Mr. Crole's account of the rise and development of the Indian tea industry forms one of the most interesting chapters in his book, although here, as in the whole work, he never loses an opportunity of casting a slur upon the China tea plant. This he stigmatises as "the pest of Assam," and its introduction a curse "that at one time seemed as if it would prove as disastrous to Assam as ever the *Phylloxera vastatrix* has been to France, or the *Hemileia vastatrix* in Ceylon." No mention is made of Fortune and his labours—which, whatever may have been his merits or demerits, is inexcusable in what purports to be an historical narrative. Full justice, however, is done to Sir Joseph Banks' efforts to introduce the Chinese plant into India as far back as 1793, and to the remarkable and accurate knowledge he showed in his selection of suitable stations for its cultivation. The discovery that a variety of *Thea* was indigenous to Assam has been claimed for a number of persons, but, according to the author, the credit indubitably belongs to Mr. R. Bruce, who first met with the plant on the hills round Rungpore in 1823. The justice of the award for this discovery, subsequently made by the Government to Mr. Bruce, which gave rise to some little controversy at the time, is thus borne witness to.

The chapters on cultivation and manufacture, although perhaps too technical for the ordinary reader, are undoubtedly the most valuable in the work. They are based upon the author's individual experience and upon a comparison of the methods employed in different parts of the various provinces, not only in Assam proper, in Cachar and Sylhet, but also in the Dooars and Darjeeling districts of Bengal, in the Punjab, in Madras and in Ceylon. They are, of course, of special interest to the planter, by whom they will doubtless be studied with the attention they merit. It is, however, noteworthy that certain minor details of manufacture, especially the operation of sorting, as usually conducted, have only served to confirm the author's inherent dislike to the beverage; for he tells us, with a perfect candour, that he never drinks tea by any chance—but rather wishes to be transported, with Pope's Belinda, to some isle where "none e'er drink Bohea."

Perhaps the least satisfactory portions of the book are those relating to the chemistry of tea during growth and manufacture. The subject is no doubt beset with difficulties, and although the author, with the assistance of Prof. Bayne, has evidently done his best, the result compares somewhat unfavourably with the rest of the work. To be told that tea contains organic acids, and that organic acids in their turn "contain the carboxyl group radical (COOH)," which is all the information vouchsafed, is not instructive to the average man, and not worth the telling to the chemist. Nor even if its construction were to be amended, is any precise information to be extracted from the following sentence. "Volatile oils . . . consist of two parts: (1) solid stearopton, and (2) liquid oleopton; all contain decone ($C_{10}H_{16}$), which is a member of the turpene series of hydrocarbons, or some polymer, and are obtained by distillation with water." The author appears to be somewhat sceptical as to the identity of caffeine with theine, and sees in the

experiments of Brunton and Cash evidence that the substances are isomeric and not identical. He finds from observations made on himself that coffee is decidedly antidotal to nicotine, whereas tea is not; but he admits that this circumstance does not go far towards proving the essential dissimilarity of the two alkaloids. By nicotine is presumably meant tobacco-smoke, which is by no means the same thing.

Mr. Crole is of opinion that the value of a tea should be in direct proportion to the theine it contains. This is surely no more true than that the value of a wine depends upon its alcoholic strength. Indeed, the author admits that what the consumer likes in tea is strength, body, and delicacy of flavour, and that he does not trouble himself about the theine, of which he has no means of estimating the amount. As a matter of fact, there is absolutely no connection between the commercial value of tea and the quantity of theine which may be present in it.

The last chapter in the book deals with the thorny question of the coolie. The Assam plantations, as well as those of Ceylon, have to depend entirely upon imported labour; but whereas the Ceylon gardens are almost wholly worked by Tamil coolies, who are free labourers, those in Upper Assam are recruited under Government licence, and by means of a system which, it is admitted, is attended with much cruelty and deception. There is, in consequence, considerable disaffection and much disquietude occasionally on the plantations, and the local magistrates are at times greatly exercised to settle the "labour troubles" which now and again break out. Mr. Crole lifts the veil only slightly, but it is sufficiently obvious that when disciplinary duty is to be done, the planter's lot, as well as that of the coolie, is not altogether a happy one. The social life on an Indian tea-garden is, perhaps, not to be judged of from a Western standpoint; but probably nothing exactly resembling a Fagua festival in wanton licence and depravity was ever seen on a Louisiana plantation, even in the best (or worst) of the "good old times."

In spite of occasional grammatical lapses and faults of style, Mr. Crole's book may be recommended as an accurate and fairly impartial account of the present state of the tea industry in our East Indian possessions.

WILD-FOWLING.

A History of Fowling, being an Account of the many Curious Devices by which Wild Birds are or have been Captured in Different Parts of the World. By the Rev. H. A. Macpherson. 8vo. Pp. liv + 511, illustrated. (Edinburgh: Douglas, 1897.)

ALTHOUGH the treatise before us can in no way be regarded as a scientific work, yet the capture of wild birds entails so many accurate observations on the habits and mode of life of the quarry, that such a full account of all that is known on the subject must of necessity throw many interesting side-lights on the study of ornithology proper. And no lover of birds will fail to find much matter worthy of his attention in Mr. Macpherson's handsome and well illustrated volume. The author appears to have spared no pains in collecting material for his history, and he has been fortunate in finding correspondents in all parts of the world who have supplied materials relating to their own particular countries which probably could not have been obtained from any other sources. Indeed, the work largely consists of extracts from the letters and publications of such correspondents, the source of which is, however, fully acknowledged both in the preface and in the text.

The work practically has the field to itself, and is long likely to remain the standard authority on the subject. The number of types of curious instruments for the ensnaring of birds Mr. Macpherson has succeeded in recording is astonishing, and speaks well for his own industry, and the interest that has been taken in the subject by his numerous correspondents. Perhaps the most remarkable of all is a snare employed in Borneo and Tenasserim for the ensnaring of the lovely Argus Pheasant. This bird, as is well known, exhibits a peculiar intolerance to the presence of any foreign object which interferes with free progress over its favourite playground. Taking advantage of this trait, the natives fix on the playground a couple of sharp bamboo knives tied together in the form of an inverted V, with their sharp edges downwards. Finding the knives thus fixed on its own particular territory, the Argus endeavours to remove them by twisting its neck round one of the blades from beneath, and, in the course of its efforts to overturn them, eventually manages to cut its own throat. In connection with this passage, it may be mentioned that the word "Argus" is omitted from the index, although it is mentioned under the heading "Pheasant."

Some limitations have necessarily had to be imposed on the extent of the subject, which might well have included punt-shooting and hawking, if not ordinary covert-shooting and driving. For since the author includes the blow-pipe and the bow-and-arrow among the engines of destruction used in fowling, there is no logical reason for the exclusion of the punt-gun and the shot-gun. But as treatises on shooting exist by the score, while hawking has also numerous works devoted to its mysteries, the author seems to have exercised a wise discretion in the limits he has laid down. And even as it is, the work extends to a very considerable bulk, although there are not a few portions where considerable abridgement would have been no disadvantage.

The author divides the implements employed in fowling into four main classes. Firstly, weapons of attack, such as the blow-pipe, the bolas, and the bumerang; secondly, the stalking-horse, or some analogous method for approaching the game without being seen; thirdly, birdlime; and fourthly, the various kinds of snares and traps, including decoys, nets, gins, &c. Having cursorily glanced at the leading types of these, Mr. Macpherson next gives a classified list of the birds treated of, and then in the text proceeds to dilate upon the particular method of capturing the members of each group or species. It is in regard to the snaring of the smaller birds that condensation might have been advantageously resorted to, as numbers of these might perfectly well have been treated *en bloc*, instead of having separate sections devoted to them, which are only too likely to weary the great majority of readers. Indeed, from the

point of view of the present reviewer, the work would have been doubled in value had it been diminished by at least one half in bulk.

Passing by these long chapters devoted to the smaller birds, more general interest will be found in the section on hawk-catching, as this is a subject on which comparatively little is often found in works on hawking; and it is decidedly interesting to know how the captors are themselves taken. We have descriptions of the capture of the Peregrine in our own islands, of the Gyrfalcon in Iceland, the Shahin in India, and many other species in different parts of the world. After full descriptions of the capture of swans and geese, several very interesting chapters are devoted to the taking of the various kinds of ducks, in the course of which driving and spearing, snaring, the different types of decoys, and clap-nets, receive their full meed of attention. The information in regard to decoying in Europe may, for the most part at any rate, be found in other works, but much of that relating to Japan and other Oriental countries appears to be new to English readers. The Japanese are described as peculiarly dexterous in the use of an ingenious collapsible triangular hand-net, in which they take the birds already enticed into the pipe of the decoy. They have three favourite methods of using this ingenious and handy instrument. The first is to spoon the duck into the net as the bird is swimming; the second, to capture the bird as it rises from the water in the pipe; while the third feat is to hurl the instrument at a duck flying out of reach, and bring it to the ground entangled in the meshes. In the course of one of these chapters on duck-catching, the shot-gun is for once introduced, in connection with a method of attracting the wily birds within range by means of a brilliant light and reflector. Another peculiarly Japanese method is to fish for ducks with a hook and line.

Numerous and various are the methods employed for trapping and decoying the various kinds of pigeons and game-birds, but, interesting as many of them are, they must be passed without notice. The last chapter relates to the ostriches and their kindred, in which we have accounts of African, Patagonian, and Australian hunting. Here the author is doubtless right in his statement that the Arabs used to kill ostriches by disguising themselves in the skin and feathers of one of these birds; but was not the same method in use among the Bushmen of the Cape?

In the matter of letterpress and illustrations the book is for the most part all that can be desired; and it can scarcely fail to claim a wide circle of readers. R. L.

OUR BOOK SHELF.

Life Histories of American Insects. By C. M. Weed, D.Sc., Professor of Zoology and Entomology, New Hampshire College. Pp. xii + 272. Woodcuts. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1897.)

WE opened this book with lively expectations of something good. Though there has been considerable activity among American entomologists during the last ten years, our knowledge of the life histories of American insects is still very defective, and there is urgent need of more labourers, especially of such as bend their minds to the solution of really important questions. Not only the title of the book, but the printing and the figures are attractive, and we began the first chapter with high hopes, only to draw a blank. The author had nothing particular to say about Belostoma. Chauliodes came next—nothing of the slightest importance here. Then came the tiger-beetles and their larvæ—again nothing new. The rest of the book is of the same slight texture. Nothing is worked out with any completeness; we have merely scraps of information, mostly from printed sources. The author's use of books is uncritical. Thus Dr. Le Conte is quoted for the explanation of the leaping of the click-beetle, and Prof. Comstock for the description of the sonorous file of the cricket, though these authors did not discover the facts for which they are cited. Let us hope that Prof. Weed or some one else will before long give us a book which is really entitled to bear the name of "Life Histories of American Insects." L. C. M.

The Röntgen Rays in Medical Work. By David Walsh, M.D. With an introductory section by J. E. Greenhill. Pp. x + 144. (London: Baillière, Tindall, and Cox, 1897.)

THIS book, as is intended, will be of interest chiefly to the medical profession. The introductory part, which deals briefly though clearly with the practical and physical side of the subject, will also be found useful by those who desire to employ X-rays for other purposes.

The book is methodically arranged, well got up, and is illustrated with a large number of remarkable and excellent specimens of X-ray photography, mostly of anatomical interest.

Altogether it contains good evidence of the real value of X-rays in practical surgery and medicine, especially the former, and of the rapid progress that their employment has made in their application to these important fields.

It is interesting to note that while the author is fully cognisant of the powerful effects that X-rays under certain circumstances may produce upon the skins of particular individuals, he is satisfied that, so far as present experience goes, they have no particular action upon micro-organisms.

The introduction is somewhat misleading where it states, on p. 23, that the action of the induction coil depends upon the fact discovered by Faraday, that an electrified body is capable of inducing a similar condition in an unelectrified body lying within the sphere of its influence. It was electro-magnetic, and not electro-static induction which Faraday discovered, and it is owing to the former, and not to the latter phenomenon that the induction coil is possible. Again, there is another slip on p. 26, where it is mentioned that kathode rays can be reflected, refracted, polarised, and deflected by a magnet just as ordinary light. Kathode rays, of course, have never been refracted or polarised, and ordinary light is not deflected by a magnet.

Air, Food and Exercises; an Essay on the Predisposing Causes of Disease. By A. Rabagliati, M.A., M.D., F.R.C.S.Ed. Pp. xvi + 220. (London: Baillière, Tindall, and Cox.)

THE book under review is an amplification of papers contributed to the *Scalpel* during the year 1896. The main proposition elucidated in the essay may, in the words of the author, be said to be this: "that there are three predisposing causes of disease, as there are, conversely, three chief predisposing causes of health, and that these are air, food and exercises." In the course of his essay, the writer gives his opinion on the subject of heredity, which, he thinks, "counts for very little as a predisposing cause of disease and of health, among adults at least, if not even among persons who have

passed the tender years of early childhood." Heredity is indeed spoken of somewhat contemptuously in the book, and, bracketed with germs, is described as a fetish, "so blindly and superstitiously is it invoked." In the opinion of the author, five per cent. would be a fairer estimate for the hereditary diseases incident to adult humanity than even ten—an estimate previously conceded in the course of the argument. The book is not written for the practitioner, by whom, in fact, many of the opinions and views of the author might be challenged, but for the lay- man and woman, who will find in it many hints as to the diet and physical exercise of the body, which may be calculated to make easier the task of keeping the body in a state of health. Being intended for the perusal of the non-professional reader, the work throughout is written in a style which will be easily understood by all.

Elementary Drawing: a Series of Practical Papers for Beginners. Written and illustrated by Elisabeth Moore Hallowell. Pp. 54. (London: Macmillan and Co., Ltd., 1897.)

AT first sight the scope of this small book does not seem to fall within the area covered by the columns of NATURE, the series of papers of which the work is composed having originally been written for the *Art Amateur*, "to give to beginners in drawing a simple explanation of some matters usually considered too elementary for text-books"; yet it will be owned by all that a knowledge of drawing is, if not absolutely necessary, very useful to the student of science in whatsoever branch he may be engaged, and thus a brief notice of the volume may not be out of place here. The book, although written in easy language, is not intended for very young readers, but "for those who are able to follow from one lesson to another, up to the point where the present volume ends and the general text-book begins." It will, we should think, be found very acceptable to many who have not had the advantage of early training in art, but who wish to gain some idea of its principles; and especially useful will it be to those to whom attendance at a drawing class is impracticable. A careful student of this unpretentious volume will be in possession of some very useful hints, and will have acquired knowledge which will stand him in good stead in his after studies.

Botanisches Bilderbuch für Jung und Alt. By Franz Bley. Part i. With explanatory text by H. Berdrow. Pp. 96. Plates 24. (Berlin: Gustav Schmidt, 1897.)

THE best way to obtain a knowledge of common flowers is to go into the woods and meadows with an outdoor botanist. Unfortunately, a naturalist cannot always be found able and willing to impart the required information, and the most satisfactory substitute in such cases is a collection of coloured pictures (uncoloured pictures are useless for purposes of identification) of flowering plants commonly seen. We have several works of this kind in our own language, a very good one being Mr. Edward Step's "Wayside and Woodland Blossoms." The volume before us is similar in character, though not so handy in size as Mr. Step's. There are 216 coloured figures of plants on twenty-four plates, and brief descriptions of each species represented. The species described and illustrated are those which flower in the first half of the year, and they are arranged according to the succession of the months. Another volume will be published for flowers of the second half-year. The figures are mostly very good, and the text has been designed to interest the reader in plant life and functions. The plant-lore referred to in the descriptions of many of the species will assist in popularising the book and making it acceptable to young students of botany in Germany.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Volcanic Condition of Stromboli.

IN view of the fact that all published accounts of Stromboli, according to the *résumé* given by Bergeat ("Der Stromboli," A. Bergeat, Habilitationschrift, München, 1896), have agreed in describing the volcano as being explosively active, there may some interest attach to a statement of the present condition of affairs, as seen by Prof. H. F. Reid, of Johns Hopkins University, and the writer, on October 27 and 28 of the present year. The westernmost of the four small craters described by Bergeat was not observed at all, the next two were discharging rather copious volumes of vapour, and the easternmost, or "old," crater was giving out a very little steam from its bottom. The most steam was issuing from cracks in the eastern rim of the "old" crater, especially from one at the north-eastern or seaward corner of the rim. Much steam was issuing from the southern rim overhanging the second and third craters and the ridge leading from it to the main mountain mass. Nothing in the nature of an eruption was taking place, and it was evident that the craters had been in this condition for some time. Later inquiry at Lipari elicited the information from Bartolo Nicotera, the guide, that there had been no eruption on Stromboli for about a year. The high ridge over the crater, known as the Cima, showed steam issuing from along its summit, more than 200 metres above the crater. E. O. HOVEY.

Naples, November 26.

The Colours of Flowers Blooming Out of Season.

I HARDLY think it probable that you will be able to spare your valuable space for my communication; nevertheless, I venture to send you the following observations on the tendency of flowers to revert in colour when blooming out of season. We have had little frost here, and many flowers which are ordinarily out of bloom at this season still persist. The changes, however, in their normal colours are in some cases very remarkable. The red cactus dahlias are blooming almost orange, the outer florets being often nearly yellow. These dahlias are also, in many cases, showing a tendency to revert to the single form. A species of tropeolum, normally vivid scarlet, is blooming in a cool greenhouse, where air is kept on, and has in some cases reverted almost to clear yellow; a streak of red down the centre of the petal being the only remains of its normal colour. In both the above cases I note that the edges of the petals are the first to change. A species of myosotis, ordinarily of a deep and very vivid blue, is flowering now a clear rosy pink, without the least tinge of blue. The flowers are well opened and normal in size. Lastly, a pure white phlox of dwarf habit shows a tendency to revert in some of its blooms, though not in all, to a greenish yellow hue. Such cases are probably common; but it is with the feeling that they may point to climatic conditions as influencing the coloration of flowers, and as having, possibly, borne a large part in the gradual evolution of their respective tints, that I venture to record them. E. HUGHES-GIBB.

The Manor House, Tarrant Gunville,
Blandford, November 20.

A Rose-Coloured Rainbow.

ON page 263 of Lord Tennyson's "Memoirs" there is mention of a "red rainbow" seen at sunset in 1882. As it was considered noteworthy by Sir Norman Lockyer, and was the first he had heard of, it may be of interest respecting sunset phenomena that near Hayward's Heath, on June 29 of this year, at sunset there was a rainbow entirely of a clear rose-pink against heavy storm clouds over half the sky, and facing a deep golden sunset in a clear sky. It was a perfect arch, and lasted for some minutes. Just for a moment I saw a streak of pale sea-green in the midst of the rose colour. M. S. ZACHARY.

Holy Cross Home, Hayward's Heath.

Critical Temperature of Water.

IN answer to Mr. Martin's letter in your last issue (p. 80), Cailletet and Colardeau found the critical temperature of water to be 365° C., the corresponding pressure being 200·5 atmos. An account of their experiments is given in Preston's "Theory of Heat," p. 384. S. GEOGHEGAN.

Dublin, November 29.

SPECTRUM OF A METEOR.[1]

THE photographs of the spectra of the stars taken at the Harvard College Observatory as part of the Henry Draper Memorial differ in two respects from those ordinarily taken elsewhere. Instead of using a spectroscope with a slit, in which but one star is photographed at a time, a large prism is placed over the object-glass of the telescope, and thus spectra of all the bright stars in the field of view are obtained. The number of stars photographed simultaneously is still further increased by substituting for the object-glass a portrait lens like that used by photographers, only larger. The field of view is in this way increased from two degrees square to ten degrees square, and a photograph is obtained of the spectra of all the brighter stars in this large region. Many thousand plates, covering the entire sky, have been taken in this way at the Cambridge and Arequipa Stations of this Observatory. All have been examined by Mrs. Fleming, and, as a result, numerous remarkable objects have been discovered. One of the latest is the spectrum of a meteor which has thus been photographed for the first time. Since it is impossible to foresee when the bright meteors will appear, or what path they will follow, a photograph will be obtained only when one happens to cross the field of the telescope. A number of trails of meteors have been obtained, both here and elsewhere, when charts of the stars were photographed, no prism being used. When the prism was in place no meteor bright enough to leave a noticeable trail has heretofore been photographed on the many thousand plates examined. At about 11 p.m. on June 18, 1897, however, when the 8-inch Bache telescope at Arequipa was directed towards the constellation Telescopium, a bright meteor appeared in right ascension 18h. 19m., declination −47° 10′, and passed out of the field at right ascension 18h. 29m., declination −50° 30′. The spectrum consists of six bright lines whose intensity varies in different portions of the photograph, thereby showing that the light of the meteor changed as its image passed across the plate. The approximate wave-lengths of these lines are 3954, 4121, 4195, 4344, 4636, and 4857, and their intensities are estimated as 40,100, 2, 13, 10, and 10, respectively. The first, second, fourth, and sixth of these lines are probably identical with the hydrogen lines $H\epsilon$, $H\delta$, $H\gamma$, and $H\beta$, whose wave-lengths are 3970, 4101, 4341, and 4862. The fifth line is probably identical with the band at wave-length 4633, present in spectra of stars of the fifth type and forming the distinctive feature of the third class of these stars. The third line, which is barely visible, is perhaps identical with the band at wave-length 4200, contained in these stars (*Astron. Nach.* 127, p. 1).

It will be noticed that of the four hydrogen lines in the spectrum of the meteor, $H\delta$ is the most intense. This is also the case in the spectrum of *o* Ceti and of many other variable stars of long period. In some variables of long period $H\delta$ and $H\gamma$ are equally intense, while in others $H\gamma$ is the more intense. In some stars of the first type in which the hydrogen lines are bright, like γ Cassiopeiæ, the line $H\beta$ is much more intense in the photographic spectrum than any of the other lines, while in the spectra of stars like P Cygni and η Carinæ, $H\delta$, $H\gamma$, and $H\beta$ are nearly equally bright. These results show an important resemblance between meteors and stars having bright lines in their spectra, and may aid in determining the conditions of temperature and pressure in these bodies. Since bright meteors sometimes appear during the November meteoric shower, a special effort will be made to obtain photographs of them, both trails and spectra, on November 13.

November 8. EDWARD C. PICKERING.

[1] *Harvard College Observatory. Circular* No. 20.

GEOLOGY AND SANITARY SCIENCE.

THE address recently delivered by Mr. W. Whitaker, F.R.S., before Section iii. of the Congress of the Sanitary Institute (*Journal of the Sanitary Institute*, vol. xviii., 1897, pp. 304–316), touches upon several matters of special interest at the present time. Section iii. deals with chemistry, meteorology, and geology, and Mr. Whitaker chose for his subject "Water," as being appropriate for such a triple alliance. Most important is his suggestion "that round each work for the public supply of water a certain tract of the water-bearing bed should be saved from the assaults of surface-contamination." The address was delivered before the Maidstone epidemic had occurred, but reference is made to it in a postcript, and no stronger support for Mr. Whitaker's proposal could have been given. He rightly observes that "we are yet without much information as to how far pollution may be able to reach along an underground course," but "it is here that geology comes in, for the nature of the surroundings of waterworks must be taken into account, often for some distance and to some depth." From a sanitary point of view the mapping of all the surface deposits on the six-inch scale by the Geological Survey is referred to as most necessary. A great deal has been done, but very much more remains to be done; and, as Mr. Whitaker observes, "a survey of the drifts in the London area on the six-inch scale is greatly needed."

It is a serious matter when sewage-farms and cemeteries are placed on porous strata, which are perhaps in adjacent tracts utilised for their supply of water; and yet, as Mr. Whitaker remarks, "sewage-farms and cemeteries must exist, until some other methods of disposing of waste material are not only found out, but are generally adopted."

Clearly there is need for greater control over the sites chosen for any of the purposes mentioned, and public sources of water-supply must be carefully safeguarded. The question of federation in the matter of water-supply in many localities is one to which attention is drawn, and this also is becoming urgent.

NOTES.

THE French Government, through its Embassy in London, has presented to Sir Archibald Geikie a handsome vase of Sèvres porcelain in recognition of the services rendered by him to the Geological Survey of France.

WE are pleased to hear of the foundation of the Zoological Society of Western Australia, with the object of establishing a Zoological Garden at South Perth in that colony. Mr. E. A. Le Souef has been appointed director of the new institution.

IT is announced that the Council of the Iron and Steel Institute have accepted an invitation from the Association of Swedish Ironmasters to hold the autumn meeting of the Institute next year at Stockholm. The meeting will be held in August, and, in view of the large quantities of Swedish iron and ores consumed in this country, there is no doubt that it will prove a very popular meeting. Previous autumn meetings of the Institute have been held at Belgium, France, Germany, Austria-Hungary, Spain, and the United States.

A BUST of Pasteur was unveiled at Melun on Monday as a memorial of his investigations on anti-anthrax serum.

THE death is announced of Dr. Harrison Allen, Emeritus Professor of Comparative Anatomy in the University of Pennsylvania.

THE Allahabad *Pioneer Mail* states that the Röntgen rays are proving of the greatest assistance in dealing with the gun-shot wounds among the troops engaged on the frontier.

THE Bradshaw lecture, in connection with the Royal College of Surgeons. England, will be delivered on Wednesday, December 8, by Mr. Alfred Willett, who will take as his subject the "Correction of certain deformities by operative measures upon bones."

THE New York Zoological Society is making headway in its undertaking to convert a portion of South Bronx Park into the largest zoological garden in the world. It has the right to use the ground; it has the plans for the chief structures to be erected; it has part of the money; and it believes that the public-spirited citizens of New York will contribute the remainder of the funds necessary. In the second number of the new bulletin issued by the Society, we read: "The Society does not propose that any feature of its work shall be performed on a small or cheap scale. The Greater New York should not plan a mere menagerie on the matchless site set aside as a Zoölogical Park. The Society is carefully studying in this country and abroad what constitutes an ideal vivarium, and it proposes to build one worthy of a great city, or none!" As already announced, the City of New York will provide 125,000 dollars to meet the cost of preparing South Bronx Park for the reception of the Society's costly buildings and collections, and making them accessible to the public, as soon as the Society's improvement fund reaches 100,000 dollars.

AT the Royal Geographical Society on December 6, Lieutenant Peary will give an account of his Arctic work. On December 13, Colonel H. W. Feilden will read a paper on recent visits by Mr. Pearson and himself to the Barents and Kara Seas and Novaya Zemlya. Mr. F. G. Jackson and Mr. Arnold Pike will also speak of their observations on the open Polar Sea of the past summer. On Friday, January 7, and Monday, January 10, at 4 p.m., two Lectures to Young People will be given by Dr. H. R. Mill; the subject being: "A Geographical Holiday through Forest, Prairie and Mountain." The lectures will be illustrated by many photographic lantern slides.

IT is proposed to erect a monument of grey granite, twenty-three feet high, over the grave of Baron von Mueller in St. Kilda Cemetery, and donations are invited for that purpose by the late investigator's executors. Botanists will be pleased to know that the Baron's supplemental volume of the "Flora Australiensis," upon which he had worked for years and was preparing for the press at the time of his death, together with two volumes on his administration as Director of the Botanical Gardens, embracing a biography and complete bibliography of his writings, are to be published. His executors will feel favoured by the loan of any of his letters, or the communication of incidents in the Baron's life which his friends deem to be worthy of notice in his biography. Subscriptions for the monument, or material for the biography, should be sent to the Rev. W. Potter, "Vonmueller," Arnold Street, South Yarra, Victoria.

THE annual dinner of the Institution of Electrical Engineers was held on Wednesday in last week, and was attended by more than two hundred members and friends. In proposing the toast of "The Scientific Societies," Prof. Ayrton compared the conditions of physical research thirty years ago with the laboratories of to-day. Lord Kelvin responded on behalf of the Royal Society, and pointed out the assistance given by that scientific Society to the advancement of natural knowledge. Sir J. Wolfe Barry replied for the Institution of Civil Engineers, and Sir James Crichton Browne on behalf of the Royal Institution. Prof. S. P. Thompson proposed the toast of "Our Guests," and the Marquis of Tweeddale and Dr. Collins (Chairman of the London County Council) replied to it. Sir Courtenay Boyle, in proposing the toast of "The Institution of Electrical Engineers," mentioned that the Board of Trade had already made 256 provisional orders for electric lighting: he hoped that electric traction would soon develop in this country. The President, Sir Henry Mance, replied to the toast, and gave a brief survey of the work of the Institution.

THE autumn meeting of the U.S. National Academy of Science was recently held at Boston. Miss Alice Bates Gould, daughter of the late Prof. B. A. Gould, who was one of the founders of the Academy, presented the sum of twenty thousand dollars, to be known as the Gould Memorial Fund, the income to be used for astronomical and mathematical purposes.—The Academy visited the Jeffersonian Laboratory at Harvard, by invitation of Prof. John Trowbridge of the Scientific School. Prof. Trowbridge exhibited his new X-ray machine. It has a voltage of 1,200,000, and with it are used 10,000 cells and 60 condensers. The condensers are charged in parallel and discharged in series by a movable framework. The spark is 48 inches long.—On the last day of the meeting, Prof. O. C. Marsh made a further contribution to the subject of the Jurassic formation of the Atlantic coast, which he has been investigating for several years. Prof. A. E. Merrill described the effects of tropical seas upon certain animals. Prof. Charles R. Cross explained experiments made by him on the wave siren for determining the pitch of musical sounds. Prof. Seth C. Chandler made a further contribution on the motion of the earth's pole. His experiments, continued for many years, warrant the statement that the area traversed by the pole does not exceed twenty feet in radius. He exhibited charts showing the varying position of the pole for seven years. Major J. W. Powell presented an hypothesis to account for movements in the crust of the earth.—After the adjournment of the meeting, members of the Academy visited the Harvard Observatory under the charge of Prof. Edward C. Pickering, and examined the apparatus and the collection of nearly 200,000 photographs of the heavens which have been made during a period of several years.—The spring meeting of the Academy will be held at Washington on April 19, 1898.

THE reports issued by the Meteorological Office on Saturday last showed that an abrupt change of the conditions of high barometric pressure, which had prevailed more or less persistently for some time past, was taking place; the wind had become more generally south-westerly, and a rise of more than 20° had taken place in the temperature, in parts of England, since the previous day. The fall of the barometer was very rapid, and by Sunday the whole type of weather had thoroughly changed; a large and important cyclonic disturbance had arrived from the Atlantic, and the centre of the storm on Sunday morning lay over the north of Scotland. South-westerly and westerly gales were blowing in most parts of our islands during Sunday, and the barometer near the centre of the storm was becoming still lower as the disturbance advanced. By 8h. a.m. on Monday the centre had travelled in a south-easterly direction across the North Sea to Denmark, causing terrific seas and northerly gales on our eastern and south-eastern coasts. The unusual track followed by the storm was probably owing to the barrier offered by the relatively higher barometric area extend-

ing over Scandinavia, while its fury was augmented by an area of high barometric pressure advancing in the rear of the storm, from the Atlantic, and thus increasing the steepness of the barometric gradients over our islands. Much damage has been wrought on our coasts by the violence of both the wind and sea, and now that the high barometric area has been displaced from over this country, further atmospheric disturbances are likely soon to reach us from the westward.

AN example of the reticulated python (*Python reticulatus*), the largest snake that has been in the Zoological Society's reptile-house for many years, and, so far as is known, the largest that has ever been there, died in the Gardens on November 14 last. It measured just over 20 feet in length. This snake was obtained in Malacca, and presented to the Society by Dr. Hampshire on August 29, 1876, and had, therefore, lived rather more than twenty years in this country. During this period it has been fed principally with ducks, of which it sometimes swallowed four or five at one meal. Its food was offered to it once a week, but it sometimes refused to eat for a month together. The specimen will be mounted for the Tring Museum. The largest snake now remaining alive in the Zoological Society's collection is a female Indian python (*Python molurus*), which measures about 18 feet in length. It was obtained by purchase in October 1889.

THE forthcoming annual report to the U.S. Congress of the Secretary of the Interior (Mr. Cornelius N. Bliss), contains much interesting information and many valuable suggestions in renard to Alaska, for which territory a government is contemplated adapted to its rapid development. In the report of the Governor of the territory, Mr. John G. Brady gives a summary of events which have transpired there during the last thirty years. He attaches great importance to the introduction of the reindeer by the Government as an important step in the solution of problems of food supply and transportation. A journey of over 2000 miles, taken with reindeer last winter by the Superintendent of the Government Reindeer Station and two Lapps, shows how well adapted this animal is to the necessities of the people there. It has this great advantage over dogs, that it can feed on the moss which grows everywhere, whereas food has to be transported for the dogs. The report states that, with care, grasses and other staple crops can be cultivated. The whole coast of Alaska, including the islands clear to the eastern end of Kadiak Island, is covered with timber of great value. Statistics regarding pelagic sealing are given, and the branding of all female pups is commended.

A WINTER weather record from the Klondike region is given by Mr. E. W. Nelson in the *National Geographic Magazine* (November). The record was obtained in the autumn and winter of the years 1880–81, at a fur-trading station on the Upper Yukon, not far from Dawson City. It covers the period from the early autumn to the opening of navigation on the Upper Yukon in spring, and is of peculiar interest at present, as showing some of the meteorological conditions in the area which is now attracting world-wide attention. The Yukon froze over on November 2, and was covered with a practically unbroken sheet of ice for more than six months. The temperature sank steadily from the end of October, and in December the lowest temperature, $-67°$ Fahr., was noted. The lowest temperatures reached in January, February, and March were $-41°$, $-58°$, and $-43°$ respectively. In the last-named month the effect of the returning sun became evident, the greatest range (88°) being obtained during that month. Not until the middle of May, however, did the ice start on the river, and it was some weeks before the river was free enough from floating ice to permit navigation.

IN the *Engineer* of November 19 there is an article upon the measurement of the velocity and pressure of the wind, with illustrations of the various parts of Dines' pressure tube anemometer and of its records. Some years ago the Royal Meteorological Society appointed a committee to consider the subject of wind force, of which Mr. W. H. Dines was a member; he took great interest in the subject and carried out an exhaustive series of experiments, the chief expense of which was borne by the Meteorological Council, who were fully aware of the importance of the subject. The experiments modified to a considerable extent the values of the results obtained by the principal anemometers then in use, viz. the Robinson cup anemometer and the pressure-plate anemometer, and ultimately led to the invention by Mr. Dines of the instrument which bears his name. It consists of two independent parts, the head, with vane, which is exposed to the wind, and the recording apparatus, which may be put in any convenient, sheltered place, at a considerable distance away. These two parts are connected by means of flexible metal tubes, and the arrangement obviates the great difficulty experienced where a mechanical connection has to be maintained between them, as in the case of the two instruments above mentioned, which can never be placed far above a building. The Dines' instrument possesses many advantages over the cup and pressure-plate anemometers, and is much cheaper, while its records combine the characteristic features of both. It is now in action at many stations both in this country and abroad, and will, no doubt, throw considerable light on questions about which there has hitherto been much uncertainty.

THE last number of the *Annales de l'Institut Pasteur* contains the report for the past year of the work carried out at the Station Pasteur de Tiflis. No less than 242 persons of very diverse nationalities received the antirabic treatment; 5 were Persians, 4 Greeks, 32 Armenians, 5 Tartars, 10 Germans, 110 Russians, &c. Bites from dogs were principally recorded; but there were also 6 from horses, 2 from cats, and 1 from a donkey. The mortality, as estimated according to the Pasteur method, only amounted to 0·45 per cent. An extremely remarkable case is specially recorded, in which a station-master was treated for hysteria, he having no recollection of ever having been bitten by any animal whatever. On being, however, repeatedly pressed, he recalled having been bitten, a year and seven months previously, by a dog in the chest. The characteristic symptoms of rabies soon declared themselves; the patient was not, however, treated for hydrophobia, and he died. Subsequent inoculations proved that he had succumbed to undoubted rabies. So prolonged a period of incubation for hydrophobia is, we believe, unknown. Experiments were conducted at the station to determine the action of Röntgen rays on the virulence of rabid marrows, and it was found that the virulence was diminished slightly by considerable exposure to these rays. Researches were also carried out to ascertain how long rabid marrows can be preserved in glycerine and water without losing their virulence, and the period, Dr. Frantzius tells us, is a longer one than Roux, Nocard, and other investigators have thought.

THE so-called canning industry has made such vast strides all over the world, and notably in America, that it is not surprising that this method of preserving foods should form the subject of inquiry at the hands of the bacteriologist. When we learn that in Baltimore alone 1,250,000 bushels of oysters are annually canned, and that the United States is responsible for 120,000,000 cans of tomatoes, and of other articles, such as fish of various kinds, and fruits, &c., in similarly large numbers, it is remarkable that Messrs. Prescott's and Underwood's paper, "Micro-organisms and sterilising processes in the canning industry," published in the *Technology Quarterly*, should be the first contribution to so important a subject. These gentlemen have

specially studied the bacterial flora of canned clams and lobsters which have broken down, or, in other words, been imperfectly preserved. In every case where "spoiling" had occurred, bacteria were present in large numbers, whilst in no instance were any discovered in sound cans. Sometimes only a single variety, or a pure culture of a particular microbe, was found in unsound cans, but usually the latter contained a mixture of several species. Nine different bacteria were selected and isolated for subsequent study, both as regards their macroscopic and microscopic appearances; two of these were cocci, the remainder bacilli forms. These bacteria were afterwards inoculated into the contents of sound cans, with the result that the latter invariably decomposed, whilst experiments were also made to test the method of applying heat to canned articles which would most effectually destroy the chances of these micro-organisms surviving and spoiling the contents. An account of the numerous experiments carried out by the authors on this highly important commercial side of the inquiry will be published later; meanwhile their investigations go to show that, given a proper control of the temperature, it is possible to preserve clams and lobsters with absolute certainty, and in a more perfect condition than has hitherto been possible.

THE *Journal de Physique* for November contains a specially good collection of abstracts of physical papers, in addition to an important paper by M. Gerrit Bakker, on the thermodynamic properties of liquids with simple molecules, and a note by M. J. Schurr, on electric resistance and self-induction.

FROM Mr. F. W. Frankland, of New York, we have received several papers on the "Theory of Discrete Manifolds," dealing with the postulates of Euclidian geometry and their hypothetical counter-propositions, space-curvature, and the geometric axioms. Almost concurrently with these essays, Signor G. Veronese gives n the *Atti dei Lincei* a disquisition on the postulate of continuity, in which he arrives at certain conclusions contrary to the views of Schönflies.

SOME ten years ago, Weber discovered that a heated body begins to emit visible radiations at a lower temperature than that at which it exhibits the well-known glow of red heat. This "grey-glow," as it has been termed, has been investigated from a physiological standpoint by Herr O. Lummer (*Annalen der Physik und Chemie*, 62). According to the author's theory the observed appearances are due to the different susceptibilities of the rods and cones of the retina to light of varying intensity, the grey-glow being perceptible only to the rods, while the red-glow stimulates the cones. It is proposed to make observations of the lowest temperature at which luminosity occurs. Herr Lummer expresses the view that this temperature depends in some degree on the area of retinal surface exposed to the radiations.

FROM a series of investigations on the temperature-coefficient of the potential of the calomel electrode (*Proceedings of the American Academy of Arts and Sciences*, xxxiii. No. 1), Mr. Theodore William Richards draws the following conclusions: (*a*) The temperature-coefficient increases with the dilution of the electrolyte; (*b*) the kation of the electrode influences the result by affecting the degree of dissociation of the chloride in solution; (*c*) both of these effects may be approximately computed by a simple logarithmic formula based upon Nernst's hypothesis; (*d*) the accuracy of the results is, however, affected by at least one important modifying influence, the "catalytic" decomposition of mercurous chloride into mercuric chloride and mercury; (*e*) this side reaction is responsible for the slight inconstancy of the normal calomel electrode; (*f*) the "decinormal electrode" is much more uniform in its behaviour than the normal, and hence for some purposes might be a more useful means of measuring potential differences; (*g*) hydrochloric acid and ammonic chloride are anomalous in their behaviour.

AMONG recent contributions to systematic botany are "North American Lemnaceæ," by Mr. R. C. H. Thompson, all four genera which comprise the order being represented; and "Contributions to the Flora of Queensland," by Mr. F. M. Bailey, in which two new species of *Nepenthes* are described and figured.

THE *Botanical Gazette* states that another botanical journal has entered the field as a popular magazine in America. The *Asa Gray Bulletin* has ceased to be the organ of the Agassiz Association, and has entered upon a larger field. It will in future be published monthly, at Washington, D.C.

THE last issue (Appendix i., 1898) of the *Kew Bulletin of Miscellaneous Information* consists of a list of seeds of hardy herbaceous plants, and of trees and shrubs (mostly ripened at Kew during 1897), available for exchange with colonial, Indian, and foreign botanic gardens, as well as with regular correspondents of Kew.

TWO useful publications recently received from the U.S. Department of Agriculture (Division of Vegetable Physiology and Pathology) are "The Bermuda Lily Disease," by Mr. A. F. Woods, attributed by the author to a variety of causes, chiefly negligent horticulture; and "Notes on the Grasses and Forage Plants of Iowa, Nebraska, and Colorado," by Prof. L. H. Pammel, illustrated by a number of excellent woodcuts. Dr. E. F. Smith sends us a reprint from the *Centralblatt für Bakteriologie, Parasitenkunde, und Infektionskrankheiten* (in English), on *Pseudomonas campestris*, the cause of a brown rot in cruciferous plants caused by a Schizomycete, hitherto known as *Bacillus campestris*. Having only a single long polar flagellum, the author regards it as belonging to Migula's genus *Pseudomonas*. The life-history and effects of the parasite are described in detail.

THE second edition of a series of "Laboratory Tables for Qualitative Analysis," drawn up by the demonstrators in chemistry of the Owens College, Manchester, has been published by Mr. J. E. Cornish. The tables show in a systematic way, how the student should proceed to examine a solid substance, to make a preliminary examination for acids, to examine acid mixtures, or make a preliminary examination of an organic substance. Following these instructions are tables for the various groups of metals. Each schedule or table occupies one sheet (except the two first tables, which cover two sheets each). The tables are thus handy for use in chemical laboratories where simple analysis has to be carried on, though the demonstrators themselves would often prefer to give the laboratary work a more educational value if they were at liberty to do so, or if time enough was allowed them. Where a course of qualitative analysis is a part of the curriculum, and the demonstrator has thirty or forty students to look after, the tables should be found useful, for they will save the student from worrying his instructor with unnecessary questions.

THE additions to the Zoological Society's Gardens during the past week include a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Mr. G. Willison; an African Brush-tailed Porcupine (*Atherura africana*) from West Africa, presented by Captain W. C. Woollett; a Flat-backed Terrapin (*Cyclemmys platynola*) from Johore, Malay Peninsula, presented by Mr. S. S. Flower; a Leopard Tortoise (*Testudo pardalis*) from South Africa, presented by Miss E. Harold; a Hawk's-billed Turtle (*Chelone imbricata*) from the East Indies, two Scorpion Mud Terrapins (*Cinosternon scorpioides*) from Guiana, eleven Dumeril's Grieved Tortoises (*Podocnemis duneriliana*) from South America, presented by Dr. J. Bach; a Smooth

Snake (*Coronella austriaca*) from Hampshire, presented by Mr. E. Penton; a Mozambique Monkey (*Cercopithecus pygerythrus*, ♂) from East Africa, a Red Deer (*Cervus elaphus*), European, deposited; two Bridled Wallabys (*Onychogale frenata*) from Australia, an Electric Eel (*Gymnotus electricus*) from South America, purchased.

THE illustrations for Profs. Parker and Haswell's forthcoming "Text-book of Zoology" have been drawn by Mr. M. P. Parker, and not Mr. N. J. Parker, as announced last week.

OUR ASTRONOMICAL COLUMN.

THE VARIABLE STAR *o* CETI (MIRA).—For many years past the brightness of this star at maximum has not come up to expectation, neither has its time of maximum occurred when predicted, a fact which might be accounted for by an irregularity of some twenty-five days either one way or the other. This year, however, as observed on November 28 by Mr. Shackleton, it was already brighter than γ Ceti (3·38), and nearly as bright as α Ceti (2·44) {Oxford Uranometria}, so that its magnitude will be about 2·9. Another observation on November 29, made at the Solar Physics Observatory, South Kensington, by the same observer and Mr. Butler, gave its brightness equal to γ Eridani (2·8) (U.A) (3·0 H.P.).

The predicted and observed maxima for the last three years are as follows:—

	Predicted (*Observatory* Companion).	Observed.	Mag.
1895 ...	December 9 ...	February 27 ...	3·8
1896 ...	November 3 ...	February 1 ...	3·5
1897 ...	November 9 ...	? ...	(2·9)?

From the observations of last year and the period of 332 days, it should be at its maximum about December 30, so that it may still be expected to increase in brightness, though its light curve is very irregular near maximum.

THE COMING TOTAL SOLAR ECLIPSE.—Owing to the presence of the plague in some parts of the country near the line of central totality, several parties intending to observe the total solar eclipse of January 22 next have had to make new arrangements. At present the following seems to represent the locations of the several parties on the central line. The most western station, Viziadurg, will be occupied by Sir Norman Lockyer with his party, backed up by the officers and crew of one of Her Majesty's ships. Karad, the next station to the east, lying on the Southern Mahratta railway, will be the place of observation by Prof. Michie Smith with his party from the Madras Observatory. Prof. Naegamvala with his followers will also probably adopt this region for work. Further to the east lies Talni, where Mr. Newall, Captain Hills, and a party from the British Astronomical Association will be stationed. Where the central line of totality cuts the road between Nagpur and Seoni, Dr. Copeland will take up his station, while about 150 miles further along the track, at Sohagpur, the Astronomer Royal and Prof. Turner will be stationed. Still further eastward, at Buxar on the Ganges, will be located two parties—one consisting of a second section of the British Astronomical Association, and the other the main party of the Great Indian Trigonometrical Survey. It is also likely that the Japanese astronomers will be in this neighbourhood. At another station, still further along the line, it is stated that the Fathers of the St. Xavier's College, Calcutta, will make observations. Profs. Campbell, Schaeberle, Todd, and not improbably M. Deslandres, will be present somewhere on the central line, but the actual positions they will take up are not yet definitely known.

SYSTEMATIC OBSERVATIONS OF OCCULTATIONS.—Herr H. Batterman has recently published (*Astr. Nach.*, 3457–8) the individual observations of a very complete set of occultations of stars by the moon, numbering altogether 641. The instrument he employed was a Merz refractor of 6 inches aperture and 8 feet focal length, and was set up at the Berlin Observatory. The object of these observations was to determine the parallactic inequality of the moon, and thence the parallax of the sun. For such an undertaking it was necessary to make observations on as many days as possible, especially near the time of full moon; the observations had, further, to be regular as regards immersion and emersion, and homogeneous as much as possible over the lunar orbit. Herr Batterman was handicapped very considerably by the local conditions of Berlin, and by being restricted as regards his visible horizon; but, nevertheless, he was able to secure a considerable number of observations in the two and a quarter years he devoted to them. This communication contains simply the individual observations, but he hopes at some future date to publish the results when the large work of computation has been completed.

THE VARIABLES S CEPHEI AND T URSÆ MAJORIS.—Mr. C. E. Peek, who is the owner of the Rousdon Observatory, Devon, has just published two very interesting series of observations relating to the light changes of the variables S Cephei and T Ursæ Majoris. All the observations were made with a Merz 6·4-inch equatorial refractor, and each is the mean of fine visual comparisons with stars that are seen in the same field of view as the variable. The author does not, however, state his actual method of observing, but we presume that this will be included in the introduction (No. 1) which he proposes to issue subsequently. In addition to the list of the individual observations, Mr. Peek has plotted the curves representing the light changes during this period of ten years (1887–1896 inclusive) over which the observations extend. These curves do not appear to have been smoothed, so that they represent the observed light fluctuations. In the case of T Ursæ Majoris, there is a very suggestive brightening about the time of minimum in nearly all the curves of this variable here drawn, and it would be interesting to know if other observers have recorded it.

SOME SYSTEMS OF METEORS.—Prof. Th. Bredikine contributes to the *Bulletin* of the St. Petersburg Academy (5th series, vol. v. No. 5) an investigation with the object of determining which member or members of our solar system have a disturbing action on those systems of meteors which the earth passes through in her revolution round the sun. The disturbing agents taken into account are: the action of some major planet, that of the earth, which is somewhat of the second order, and last, but not least, that of the sun, whose power acts in two ways, namely, first by attraction, and secondly by creating great disturbances in the nucleus. In nearly all cases the sun's effect is predominant, especially when the distance at perihelion passage is small, but sometimes a near approach to one of the major planets is very marked. Prof. Bredikine has previously shown that from an examination of comets' tails the force of projection at the times of outbursts is sufficient to convert the orbits of several of the composing particles from parabolic to elliptic of short period. He assumes that all meteor streams contain particles originally belonging to comets which passed through the solar system, and lost matter by disturbing actions of the members of this system. Employing as a starting-point the positions of some of the more prominent radiant points, as given in the catalogue published by Mr. Denning in the *Monthly Notices* (May 1890), he investigates the probable disturbing agent in each case. Most of the meteor streams dealt with have, according to this investigation, resulted from large disturbances at the nucleus caused by the sun itself; among these are the Leonids, Quadrantides, Geminides, Aquarides, &c. The Orionides owe their presence to the planet disturbing influence of Jupiter, while the Lyrids are due to that of Saturn.

COMET PERRINE (OCTOBER 16).—The ephemeris of comet Perrine, which we have recently given in this column, begins now to indicate variations from the observed place. Herr Möller (*Astr. Nachr.*, No. 3459) has therefore determined new elements from the variation of proportionate distances, using the observations made on October 16, Mount Hamilton; October 24, Hamburg; and November 1, Arcetri, Florence. The following are the new computed positions:—

Ephemeris, 12h. Berlin M.T.

1897.	R.A. h. m. s.	Decl. ° ′	log r.	log Δ.	Br.
Dec. 2 ...	18 10 37 ...	+54 56·5 ...	0·1334 ...	0·0539 ...	0·7
3 ...	10 4 ...	54 25·0			
4 ...	9 33 ...	53 54·6			
5 ...	9 4 ...	53 25·4			
6 ...	8 38 ...	52 57·2 ...	0·1325 ...	0·0704 ...	0·6
7 ...	8 14 ...	52 30·0			
8 ...	7 52 ...	52 3·8			
9 ...	7 31 ...	51 38·5			
10 ...	18 7 12 ...	+51 14·2 ...	0·1325 ...	0·0858 ...	0·6

THE ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

TUESDAY last being St. Andrew's Day, the anniversary meeting of the Royal Society was held in their apartments at Burlington House. The auditors of the Treasurer's accounts having read their report, and the Secretary having read the list of Fellows elected and deceased since the last anniversary, the President (Lord Lister) proceeded to deliver the anniversary address. The medals were then presented.

The Society next proceeded to elect the officers and council for the ensuing year. The following is a list of those elected:—President: Lord Lister. Treasurer: Sir John Evans, K.C.B. Secretaries: Prof. Michael Foster, Prof. Arthur William Rücker. Foreign Secretary: Sir Edward Frankland, K.C.B. Other Members of the Council: Prof. William Grylls Adams, Prof. Thomas Clifford Allbutt Sir Robert Stawell Ball, Rev. Thomas George Bonney, Prof. John Cleland, Prof. Robert Bellamy Clifton, Prof. James Alfred Ewing, Mr. Alfred Bray Kempe, Dr. John Newport Langley, Dr. Joseph Larmor, Prof. Nevil Story Maskelyne, Prof. Raphael Meldola. Prof. Edward Bagnall Poulton, Dr. William James Russell, Dr. Dukinfield Henry Scott, Prof. Walter Frank Raphael Weldon.

The following is the address of the President:—

Since the last anniversary meeting fifteen Fellows and six Foreign Members have passed away.

The deceased Fellows are—

Edward Ballard, January 19, 1897, aged 76.
Charles Tomlinson, February 15, 1897, aged 89.
Samuel James Augustus Salter, March 1897, aged 72.
James Joseph Sylvester, March 15, 1897, aged 83.
Edward James Stone, May 9, 1897, aged 66.
Major-General Robert Mann Parsons, May 20, 1897, aged 68.
Sir Augustus Wollaston Franks, May 21, 1897, aged 72.
Sir John Charles Bucknill, July 19, 1897, aged 79.
Right Hon. Anthony John Mundella, July 21, 1897, aged 72.
William Archer, August 14, 1897, aged 65.
Lieutenant-General Sir William Francis Drummond Jervois, August 17, 1897, aged 76.
John Braxton Hicks, August 28, 1897, aged 74.
Charles Smart Roy, October 4, 1897, aged 43.
James Heywood, October 17, 1897, aged 87.
Rev. Samuel Haughton, October 31, 1897, aged 76.

The Foreign Members are—

Emil Heinrich du Bois Reymond, December 26, 1896, aged 79.
Carl Weierstrass, February 20, 1897, aged 82.
Alfred Louis Olivier Des Cloiseaux, May 8, 1897, aged 79.
Julius von Sachs, May 29, 1897, aged 65.
Johannes Japetus Smith Steenstrup, June 20, 1897, aged 84.
Rudolph P. H. Heidenhain, October 1897, aged 63.

Of these some seem to demand special notice from this Chair.

In Sylvester, English mathematical science has lost one of its best known and most gifted exponents. During his long and active career he wrote several hundreds of memoirs on the most refined and technical parts of pure mathematics. It is not for me to attempt to enumerate even the most important of his labours, which were as solid as they were brilliant. To quote the words of one well qualified to judge, "originality, imagination, and enthusiasm were the ever present notes in the chords which he struck with a master's hand; and it may be safely predicted that he will always find an honoured place in the small roll which contains the names of the men who have been pre-eminent in the science which he loved and to which he devoted his life."

Our Fellow for more than fifty years, he received the highest recognition our Society can bestow, having been awarded a Royal Medal in 1861, and the Copley Medal in 1880. No less was he honoured by other countries, foreign scientific academies having showered their distinctions upon him. Thus full of honours, as of years, he died at the advanced age of eighty-three.

In Sir Augustus Wollaston Franks we have lost one of the most distinguished archæologists of this or any other country. During a connection with the British Museum extending over a period of forty-five years, he practically founded the Department of British and Mediæval Antiquities and Ethnography, and its growth was in no small degree due to his private liberality.

In all that related to the subject of the antiquity of man, he was one of our first authorities; and the Christy collection of which he was a trustee, and which is now incorporated with the British Museum, assumed its present great importance under his careful superintendence and through his generous aid. The mediæval collections which he bequeathed to the nation testify alike to his taste and judgment and to his rare munificence.

The Rev. Dr. Haughton was a man of great intellectual power and amazing versatility. He made original contributions, based often upon very laborious researches, to physics, chemistry, geology, biology, and medicine, while continuing to discharge from time to time the functions of a minister of the gospel. If his many-sidedness prevented him from attaining a high eminence in any one branch of science, it pre-eminently fitted him for the place he was to fill in the government of a large educational institution.

After receiving his school education in his native town of Carlow, he proceeded to Trinity College, Dublin, where, his brilliant studentship having procured him a Fellowship at an unusually early age, he threw himself with great zeal into the educational work of the University. As a boy he had been fond of geology, and as a young man he so greatly distinguished himself in it that at the age of thirty he was appointed to the Geological chair in Trinity College. Here he found himself unable to deal satisfactorily with fossil remains without a knowledge of comparative anatomy, and for this an acquaintance with human anatomy seemed an essential preliminary. Thus he was drawn to Medicine, for which indeed he had an early predilection; and entering comparatively late in life on medical study, he devoted himself to the entire curriculum with characteristic energy. Soon after he had taken his medical degree, an epidemic of cholera occurred in Dublin, and he showed the true spirit of a devotee of Medicine by placing himself at the head of a band of medical students, to supply the want of any adequate system of nursing. In this self-denying labour Haughton bore more than his full share, and its beneficial results left in his mind an abiding sense of the value of bedside work. He was thus led to found medals for the encouragement of clinical study; and the last act of his life was, out of very scanty savings, to provide for making those rewards more substantial.

In the course of his studentship he had been deeply impressed with the abuses which then existed in the medical department of Trinity College, and on becoming connected with the governing body, he entered on the task of reform with indomitable courage; and it was mainly due to his exertions that the school was raised from a comparatively subordinate position to the leading place which it now holds.

The high opinion entertained of him by his colleagues was shown by the fact that he was for many years their representative on the General Medical Council. He was of a most genial and loyal nature, and it is said of him that, while he made many friends, he never lost one.

Edward Ballard was one of the chief promoters of the sanitary science of the Victorian era. His researches into problems regarding public health, which extended over forty years, were characterised by very remarkable far-sightedness and exactitude. To him we are indebted for most of our certain knowledge on the subject of effluvium nuisances in their relation to health, and for the indication of trustworthy means of mitigating the deleterious influences of noxious trades. He, too, was among the first to insist on the importance of strict study of the ætiological relations of "sickness" and "mortality"; and by his labours in this connection he laid a foundation for that system of compulsory notification of infectious illness which is now practically universal in this country. But Dr. Ballard's completed work in these and other directions by no means represents the full measure of the value of his services to public health. By his industry in the accumulation of facts bearing on a number of unsolved problems, and his exposition of such facts in their several connections, he has not only indicated lines of further research, but has tended to lighten the labours of those who will come after him. He was a man of noble nature; and the devotion of his great abilities to the service of mankind was utterly devoid of self-seeking.

James Heywood was a man of considerable scientific attainments, who deserves to be specially remembered on account of his great services in the cause of university reform. He was born in 1810 at Everton, Lancashire, and on leaving school at Bristol, entered Trinity College, Cambridge, where he was

Senior Optime in 1833. He could not, however, proceed to his degree until twenty-three years later, on account of the religious tests which were only abolished in 1856 by the Cambridge University Reform Act. Of this, as member for North Lancashire, he was the chief promoter: for, already in 1854, he moved and carried, after several previous attempts, a clause by 233 against 78, in favour of the abolition of religious tests for the Bachelor's degree in Arts, Laws, Medicine, and Music. There can be no doubt that this fundamental reform led the way to the introduction of experimental science into our universities.

He was one of the original trustees of Owens College, Manchester, and took a keen interest in the establishment and development of the scientific chairs in that institution. He was elected into the Royal Society in 1839, and was, at the time of his death, the Fellow of longest standing.

On February 19 last, Karl Weierstrass, one of our Foreign Members, died in his eighty-second year. He was elected a Foreign Member in 1881, and in 1895 the Copley Medal was awarded to him in recognition of the contributions he had made to pure mathematics. The grounds on which the award was made were set out in the President's Address in that year; and so it is not necessary now to refer in detail to his researches. The results which he obtained and the rigorous precision of method which he adopted have made his influence remarkable; and it can fairly be claimed for him that he is not the least eminent on the roll of the great mathematicians of the century.

Alfred Des Cloizeaux was a veteran mineralogist of great eminence. His first paper was published fifty-four years ago, and was the beginning of a long series treating of the forms and optical characters of crystals. After being Professor of Mineralogy for eighteen years at the École Normale Supérieure, he was appointed to the charge of the minerals at the Musée d'Histoire Naturelle, in which office he remained until he reached the limit of age prescribed by the rules of the French Civil Service. His fame rests upon the thoroughness and accuracy of his systematic investigation of the crystals of minerals, more especially as regards their optical properties. The results are incorporated in his "Manuel de Minéralogie," a standard book of reference. Prof. Des Cloizeaux died in the eightieth year of his age.

In Julius von Sachs botanical science has lost one of the most conspicuous figures of the latter half of the century. His wide-spread influence was due in the main to two memorable books.

In his "Experimental-Physiologie" (1866) he at once put the subject on a new footing. He returned to the methods long ago pursued by Hales and Knight in this country, and, while giving a critical estimate of the results achieved by his predecessors, everywhere turned the light of experimental investigation on the problems presented by the living plant. The success which he met with was due to a broad grasp of general principles and a singular directness of aim at the object in view, associated with great experimental skill. In his mechanical ingenuity and aptitude for making simple yet effective appliances he somewhat resembled Faraday.

His "Lehrbuch" (1868) produced a profound impression on the teaching of botany both in Europe and America. It did for botany what Gegenbaur achieved for zoology, in presenting the morphological facts of the vegetable kingdom for the first time as a whole. As with the "Experimental-Physiologie," it was no mere compilation, but was at every point subjected to the test of original investigation.

Sachs, moreover, presented the somewhat unusual combination in science of great gifts of original investigation accompanied by no less great gifts of exposition. The insight of his attack on a problem was equalled by the masterly lucidity with which he expounded his results.

Emile du Bois-Reymond, who died in December of last year at the age of seventy-eight, was a Foreign Member of the Royal Society since 1877. Although born in Berlin, he was of French-Swiss extraction, his father being a native of Neufchâtel, and his mother belonging to a French Huguenot family. He studied in the Universities of Berlin and Bonn, and took his Doctor's degree in Medicine in Berlin. In 1840, at the age of twenty-two he became the assistant of Johannes Müller, whose successor he was appointed, in the chair of Physiology in Berlin, in 1858. He has himself told us that it was Johannes Müller who first turned his attention to the study of animal electricity, to which the labours of his life were chiefly devoted. His publications on the subject were very numerous, while his observations were characterised by mathematical accuracy which stamped them as trustworthy. And it is not too much to say that his discoveries constitute the main fabric of our knowledge of animal electricity.

Although his energies were chiefly devoted to one branch of physiology, he was not unmindful of other departments of the science. Ever since 1859 his name has been associated with the editorship of the "Archiv für Anatomie und Physiologie," which he carried on in conjunction with Reichert, after the death of Johannes Müller. He was a man of wide sympathies and high culture. His semi-popular discourses, scientific, literary, and historical, are models of well-selected language, clear exposition, and deep erudition. His address "On the Limits of Natural Knowledge" has passed through numerous editions, and has been translated into many languages. Du Bois-Reymond ranks with men like Bernard, Brücke, Helmholtz, and Ludwig, as one of those by whom the science of modern physiology has been built up.

As regards the work of the Society during the past year I have little to add to the Council's Report.

On July 15 I had the honour of taking part in a deputation to the Queen at Windsor to present the address of congratulation which had received the sanction of the Society. On this memorable occasion I was accompanied by the other officers, including all the Vice-Presidents, and also by three former Presidents, whom we all revere, Sir Joseph Hooker, Sir George Stokes, and Lord Kelvin. Her Majesty received us in person, and made the following very gracious reply:—

"I thank you for your loyal and dutiful Address. I am much gratified by the attachment which your ancient and learned Society expresses to my Throne and Person.

"I am fully sensible how far the labours and ingenuity of men of science, whom you worthily represent, have advanced the industrial and social prosperity of my people, and have tended alike to their good and refinement, and I confidently expect the same excellent fruit in years to come from the indefatigable and reverent investigation of nature for the promotion of which the Royal Society was founded."

In the early part of the year a deputation from the Royal Society, the British Association, and several others of the most important scientific and technical societies, waited upon the Prime Minister to urge upon him the importance of establishing in this country a National Physical Laboratory in which the testing and verification of instruments and the construction and improvement of standards of various kinds should be undertaken in a regular and systematic way. There was nothing new in principle in this proposal. Work of the kind referred to has for many years been carried out at Kew under the auspices of the Royal Society. It has been as successful as the limited means at the disposal of the Kew Observatory Committee would allow; and all that is needed is sufficient State aid to enable work of the same kind to be done on a larger and more useful scale.

It is satisfactory to be able to state that the efforts of the deputation were not in vain. A committee, of which Lord Rayleigh is chairman, has been appointed by the Treasury to investigate and report upon the desirability of the scheme. Evidence is being taken, and we may fairly hope that the Government will finally consent to promote an undertaking which could not fail to advance the interests both of pure science and of scientific industry.

In January last I was requested by the Council to approach the India Office in order to call their attention to Yersin's treatment of bubonic plague, which was causing such grave anxiety in the Bombay Presidency. I gladly undertook this service, as I had been greatly impressed with an account which that distinguished man, himself an independent discoverer of the plague bacillus, had given of a trial he had made of his remedy in China. The cases were, indeed, not very numerous, but the success recorded was most striking, and was in every detail so exactly proportioned to the shortness of the duration of the disease at the time when the treatment was begun that it was difficult to conceive it to be a matter of accidental concomitance. A similar correspondence of results with theory, taken along with complete trustworthiness of the source of information, had made me early feel and express confidence in the analogous serum treatment of diphtheria, which has since proved of such signal benefit to the community.

I was received at the India Office with the utmost cordiality, and I am not violating confidence when I say that my repre-

sentations tended to strengthen the Home Government in their disposition to afford encouragement to M. Yersin to labour in the stricken district.

The vague rumours which reached us some time ago regarding his work in Bombay were not of an encouraging character. But I was glad to see from a paper read lately by M. Metchnikoff at the International Medical Congress in Moscow, that the treatment had been by no means a complete failure, and that the smaller degree of success than that obtained in China was sufficiently explained by the fact that the serum in the present state of knowledge takes a very long time to prepare, and Yersin had been obliged to employ what he knew was not as potent as that which he used in China. We may therefore fairly hope that in due time, if the pestilence should last so long, the original full measure of success will be again obtained.

The communications made to the Society during the year have been of a high order of excellence. In illustration of this I must content myself with referring to two examples taken from the domains of physics and biology respectively. The remarkable series of ten papers by Profs. Dewar and Fleming, describing their continued researches on the electric and magnetic properties of matter at low temperatures, have brought before us new facts of fundamental importance. Such, for instance, is their discovery that at very low temperatures the electrical resistance of bismuth is remarkably increased by transverse magnetisation; so much so that the observations seem to indicate that at the absolute zero pure bismuth would be a perfect conductor if not in a magnetfc field, but a perfect non-conductor if transversely magnetised.

The illustration which I will take from the domain of biology is the recent communication of Mr. Gardiner on the Histology of the Cell-Wall. Before 1883, when his former paper on this subject was published in our *Proceedings*, other observers had seen and described threads passing through the walls of certain vegetable cells, and supposed to connect the protoplasm of one cell with that of adjacent ones. But the observation had only been made in certain exceptional cases, and, moreover, they were not of such a character as in Mr. Gardiner's opinion to afford conclusive evidence that the threads really consisted of protoplasm. Since the date referred to he has laboured at this most important subject with remarkable ingenuity and perseverance; and by new methods of preparation varied to overcome the special difficulties presented by the various forms of tissue, he has succeeded in demonstrating, throughout the long series of cases which he has already examined, the presence of threads of undoubtedly protoplasmic nature, often of exquisite delicacy, passing in large numbers through the walls of adjacent cells, not only where they are thinned by the presence of pits, but elsewhere also. And to use his own words, "there can be little doubt that such connecting threads occur universally in the cells of all the tissues of all plants. From this arises the fundamental conception that the plant body must be regarded as a connected whole." And the transmission of impulses and of nutrient material from one part of the vegetable organism to another, quite unintelligible as long as the protoplasm of each cell was believed to be shut off from that of its neighbours by a wall of cellulose, receives a ready explanation.

The attendance at our meetings during the past session has been very satisfactory. There can be no doubt that the great improvement which has taken place of late years in this respect has been in no small measure due to the alteration of the time of meeting to the afternoon, which is more convenient to the large majority of the Fellows than the evening. I thus freely admit that the change has been very advantageous, although I was opposed to it when it was made, as I was apprehensive that it would interfere with participation of members of my own profession in the work of the Society; for I should greatly regret anything like a severance of Medicine from the Royal Society, believing as I do that they are very helpful to each other, medical practice affording the suggestion and stimulus of much scientific investigation, while it is often the ultimate test of the validity of the conclusions arrived at.

At the risk of seeming to dwell too much upon matters connected with the healing art, I am tempted to refer to one recent instance of its intimate connection with science. In the Society's *Proceedings* for 1893 (vol. liv. p. 187) appeared a paper by Dr. Monkton Copeman, relating important researches on Variola and Vaccinia, and referring to a discovery which he had announced two years previously at the International Hygienic Congress, in London (*Trans.* of Internat. Congress of Hygiene, 1891), that an admixture of glycerine in certain proportions with vaccine lymph derived from the calf had the effect of causing, in no long time, the disappearance of what he termed the "adventitious microbes" invariably present in that material at the outset, without diminishing the efficacy of the lymph for the purpose of vaccination. It had been known before that glycerine might be added to the lymph without destroying its vaccinal property, but that it would thus cause the disappearance of concomitant microbes was quite new. In the scant intervals of leisure permitted by his duties as inspector under the Local Government Board, Dr. Copeman has continued to prosecute his researches. He has ascertained, among other things, that if tubercle bacilli are intentionally mixed in considerable quantity with the lymph, they soon lose their life under the influence of the glycerine, thus removing the last rational objection that could be urged against vaccination. For while the use of calf lymph excludes the possibility of conveying human disease in general by the process, the cow, like man, is liable to tuberculosis. It is true that tubercle is very rare in the young animal, and that the practice of killing the calf after it has furnished the vaccine and subjecting the body to competent inspection before the lymph is set aside for use, would reduce the risk of communication of the disease almost to zero. But it is satisfactory to learn that Dr. Copeman's process makes such a thing absolutely impossible. It further turns out that the use of the glycerine, so far from impairing the efficacy of the lymph for vaccination, considerably enhances it; so that it becomes susceptible of large dilution, one calf thus furnishing material for a much greater number of vaccinations than was formerly thought possible. And further the glycerinised lymph being stored in sterile glass tubes, the chance of contaminating the vaccination scratches with extraneous impurities, somewhat difficult to prevent in vaccinating directly from the calf, is entirely avoided. Lastly, it has been found that the inflammatory disturbance at the seat of vaccination in the human arm, with concomitant febrile disturbance, is greatly lessened by the use of the pure essential ingredient.

Comparatively little advantage has yet been taken of the system in this country. But it has been otherwise abroad; and the English Commission on Vaccination having made favourable reference to the subject, the President of the Local Government Board recently requested their Medical Officer, Sir Richard T. Thorne, to make a tour of inspection of the continental practice. In this he was accompanied by Dr. Copeman, and we learn from the report which they have issued that they found our countryman's precepts very extensively acted on in the various countries which they visited. In Germany, especially, they are carried out with the thoroughness characteristic of that nation, so much so that while arm to arm vaccination has been entirely discarded, the use of glycerine-stored lymph has almost entirely superseded the practice of vaccinating from calf to arm.

It has given me pleasure to learn that Mr. Chaplin is likely soon to propose legislation for the purpose of giving the full benefits of this valuable process to the country of its discoverer.

It afforded great though melancholy satisfaction to the Treasurer and myself to be present last Christmas at the final obsequies of the man to whose labours is due the possibility of carrying on such investigations as those just referred to. M. Pasteur was buried in his own "Institut" with a splendour befitting the memory of so great and good a man.

I have also been glad to be the means, as President of the Society, of aiding our French brethren in erecting a monument to him to whom the world in general owes so much. Having received last year a letter from the Perpetual Secretary of the French Academy inviting my help in raising a fund to supplement that which was being subscribed in France, I called a meeting held here on March 26 of last year, at which it was decided to form a committee, in order to collect contributions to the International Pasteur Memorial. I wrote in the first instance to such of our Fellows as are members of the Academy, requesting them to allow their names to be on the committee, and received in almost every instance a cordial assent. Our Treasurer having consented to act as treasurer to the fund, and Prof. Percy Frankland undertaking the somewhat onerous duties of secretary, a sum has been raised, amounting in all to 877*l*. 0*s*. 3*d*., from which 17*l*. 7*s*. 2*d*. was deducted for expenses, leaving a balance of 859*l*. 13*s*. 1*d*.

I know that our French friends were much gratified by this result; and I learn from a letter written to the Treasurer by

M. Bertrand, acknowledging a final cheque, that the monument in Paris promises to be worthy of its object.

It is noteworthy that rather more than half the entire sum contributed has come from India, chiefly from the medical officers, through Surgeon-General Cleghorn. It seems probable that their great liberality was prompted by a sense of gratitude for the good work done on Pasteur's lines in that great dependency, such as Haffkine's preventive inoculations against cholera, and the efforts being made to cope with the plague in Bombay.

I have the sad pleasure, if I may so express myself, of announcing that my old friend, that distinguished medical officer and very gallant soldier, Sir William Mackinnon, late Director-General of the Medical Department of the Army, has, by will and codicils dated 1896 and 1897, after making certain specific legacies, including one of 2000*l.* to the University of Glasgow, bequeathed the whole residue of his property to the Royal Society, subject to certain life annuities. The proceeds of the fund are to be applied by the Royal Society for the foundation of such prizes and scholarships for the special purpose of furthering Natural and Physical Science, including Geology and Astronomy, and for furthering original research and investigation in Pathology, as the Society may think best and most conducive to the promotion of those sciences and of original discoveries therein; such prizes and scholarships to be called after the name of the testator.

COPLEY MEDAL.

Prof. Albrecht von Kölliker, For. Mem. R.S.

The Copley Medal is given to one who well deserves the highest honour that it is in the power of the Royal Society to confer. For nearly sixty years past Albrecht von Kölliker has made contributions of the highest value to histology, embryology, and comparative anatomy. Though his labours have embraced so wide a field, they have always been of a high order of excellence, and have often been of far-reaching significance.

His early histological discoveries were invaluable for the systematic development of the cell theory. Of these I must, on the present occasion, content myself with referring to two: his demonstration of the continuity between the nerve fibres and nerve cells of Vertebrata in 1845, followed by his memoir on nerve cells in 1849; and his isolation in 1848 of the cellular elements of smooth muscular tissue, together with his essay on the distribution of smooth muscle in the vertebrate body, and his final demonstration of the existence of muscular tissue in the walls of the blood-vessels, where its presence, although previously asserted by Henle and Sharpey, was at the time denied by Arnold and many others.

These are examples of the histological results achieved by von Kölliker during the first ten years of his scientific activity. They are of fundamental importance, and they have been followed by a long series of other valuable histological discoveries. The whole series show not only his power as an investigator, but the wide range of his knowledge, and the eagerness with which he has appreciated and applied whatever was new in the work of others. This last quality is well shown in his various essays on the structure of the nervous system, from his early acceptance of Remak's statements concerning non-medullated nerves, to his work of the last few years.

Prof. von Kölliker's influence upon histological science is due not only to his fame as an investigator, but in part also to his skill as a teacher and as a writer. Every successive edition of his text-book has been an important addition to the literature of the subject.

Among his embryological papers, that dealing with the development of Cephalopods, dating from 1844, is still a standard work, and figures copied from it are to be found in most modern text-books. His memoir on the development of Amphibia (1846) contains important statements on the behaviour of the nucleus during segmentation, and on the formation of cartilage and blood-vessels. The papers on the development of the skull (1849-50), and the subsequent work on the part played by the notochord and its sheath in the formation of the vertebral column, must be mentioned as of fundamental importance. His many later researches on mammalian embryology, which are summarised in the various editions of his text-book of vertebrate embryology, need not now be mentioned in detail.

Although it is as a histologist that von Kölliker is pre-eminently distinguished, his zoological papers are numerous and important. Among his labours in this direction were his early demonstration of the unicellular nature of the Gregarinidæ, his description of the Dicyemidæ, his memoirs on the structure and development of the Hydroids and Medusæ, and his later magnificent works on the Alcyonaria.

Many of von Kölliker's papers have appeared in the *Zeitschrift für Wissenschaftliche Zoologie*, founded by him and von Siebold in 1848, of which he is still one of the chief editors. It is pleasing to know that, at the advanced age of eighty, he is still able to prosecute with unflagging zeal his work as an investigator and as a teacher. One of the reasons of his absence to-day is his reluctance to leave his lectures.

ROYAL MEDAL.

Prof. Andrew Russell Forsyth, F.R.S.

One of the Royal Medals is awarded to Prof. Andrew Russell Forsyth on account of his contributions to the progress of pure mathematics.

He is known principally for his excellent treatises on many subjects of mathematical analysis. These works are not mere compilations; they contain original work, and exhibit great creativeness of thought.

The treatise on differential equations was immediately successful, and established firmly his reputation as a teacher. This was followed by a scholarly work on Pfaff's problem and, later, by the treatise on the Theory of Functions, the first in English on the subject, and noteworthy for the manner in which the parallel theories of Cauchy, Riemann, and Weierstrass are marshalled. The appearance of this work is responsible for the newly awakened interest in this country concerning the great works on this subject of Weierstrass, Jordan, Klein, Lie, Poincaré, and Mittag-Leffler.

Prof. Forsyth is, in addition, a prolific author on other subjects covering a wide range of pure mathematics.

ROYAL MEDAL.

Lieut.-General Sir Richard Strachey, F.R.S.

The other Royal Medal is conferred on Lieut.-General Sir Richard Strachey for his investigations in physical and botanical geography, geology and meteorology. Two of the most recent of these are recorded in his report, published in 1888, on the barometrical disturbances and sounds produced by the eruption of Krakatoa, and in his paper in the *Phil. Trans.* of 1893, entitled "Harmonic Analysis of Hourly Observations of the Temperature and Pressure at British Observatories." These, while important in themselves, were but the last of a long series of valuable memoirs. He was the first to treat scientifically of the physical and botanical geography, geology, and meteorology of the Western Himalaya and Tibet. His numerous papers on these subjects, dating from the year 1847, are published in the *Journals* of the Bengal Asiatic, Geological, and Royal Geographical Societies, in the Royal Society's *Proceedings*, and in the Reports of the British Association.

Sir R. Strachey's scientifically annotated and very complete botanical collections made in Kumaon, during his physical survey of that province (in company with Mr. Winterbottom), and in Tibet, at all elevations from 2000 to 18,500 feet, are unique in value and interest, as being the first from which could be determined the successive zones of vegetation according to altitude in the mountains of any part of Asia.

Sir R. Strachey is justly regarded as the founder of scientific meteorology in India, whether by virtue of his early personal labours in that branch of science, or for the zeal and energy with which, during his long career as a member, first of the Government of India in that country, subsequently of the Council of the Secretary of State, he promoted the establishment of meteorological observatories and stations all over our Eastern dominions. Nor were his exertions in this respect confined to meteorology, for there are few scientific institutions or publications now supported by the Indian Government which are not largely indebted for their existence or organisation to his efforts.

DAVY MEDAL.

Dr. John Hall Gladstone, F.R.S.

The Davy Medal is awarded to Dr. John Hall Gladstone on the ground of the great extent and value of his chemical and physical researches, extending over a period of forty-nine years. His first paper was printed in 1847, and his last in the *Proceedings* of the Royal Society for 1896. During

[Photographed by Elliott and Fry, Baker Street.

PROF. A. R. FORSYTH (ROYAL MEDALLIST).

[Photographed by A. J. Melhuish, Pall Mall.

LIEUT.-GENERAL SIR RICHARD STRACHEY, G.C.S.I. (ROYAL MEDALLIST).

[Photographed by A. J. Melhuish, Pall Mall.

DR. J. H. GLADSTONE (DAVY MEDALLIST).

[Photographed at Claudet's Photo. Studio, Regent Street.

SIR JOHN SIMON, K.C.B. (BUCHANAN MEDALLIST).

this time he has published seventy-six papers, recording the results of his own researches, and forty-eight relating to investigations made in conjunction with other workers.

These papers cover a wide range of subjects. In chemistry he showed, in 1847, that urea is formed by the breaking up of some of the salts of fulminic acid. He demonstrated the composition of the so-called iodide of nitrogen. His memoir on the relations of the atomic weights of the elements suggested analogies with the homologous series of organic compounds. An important monograph on chemical affinity occupies forty-five pages of the *Philosophical Transactions* of 1855; in it the behaviour of salts in solution is discussed with much acuteness.

Amongst Dr. Gladstone's other very numerous contributions to chemical science, may be mentioned the study of the influence of carbonic anhydride on the germination of plants, his researches on the chemistry of storage batteries, on the molecular weight of caoutchouc and gums, and on the zinc-copper couple and its application to the production of organo-zinc compounds and the hydrides of the organic radicals. Dr. Gladstone's new and simple method of producing organo-zinc compounds conferred a most valuable boon upon organic chemistry, and led to the very extensive use of these bodies in organic research, and consequently to many important discoveries in that domain of chemistry.

Amongst Dr. Gladstone's numerous researches in physical chemistry, may be mentioned the following:—"On the Spectra produced by Solutions of Coloured Salts in Hollow Prisms"; "On the Use of the Prism in Qualitative Analysis" (1857). He shows that when a coloured acid and base combine, a solution of the salt so formed only allows those rays to pass which are not absorbed by either constituent separately. He taught us the optical detection of didymium in the same year, and also studied the influence of heat on the colour of saline solutions, showing that whilst in some cases the intensity only of the colour was altered, in others the tint was completely changed. In 1860 he published a useful paper on the use of the polariscope in chemical investigation. Of his other papers on physical subjects, the following may be mentioned:—"On the Connection between the Optical Behaviour, Specific Gravity, and Chemical Composition of Ethereal Oils"; "On the Refraction Equivalents of some Elements"; "On the Refraction and Dispersion Equivalents of Chlorine, Bromine, and Iodine"; "On the Refraction Equivalents of Carbon, Hydrogen, Oxygen, and Nitrogen"; "On the Specific Refraction and Dispersion in Isomeric Bodies"; and (with Dr. Perkin) "On the Relation between Molecular Magnetic Rotation and the Refraction and Dispersion of Nitrogenous Compounds."

One of Dr. Gladstone's most important investigations was the determination of the refractive equivalents of many of the metals. The object was not, however, only to determine these equivalents, but also to answer the question whether any of the elements possessed more than one refractive equivalent. As the refractive indices of the metals could not, on account of their opacity, be directly determined, he operated upon solutions of their salts, first proving, in cases where both solid and solution were available, that the refraction was the same in the solid and in its solution, whether the solvent was aqueous or alcoholic, and whether concentrated or dilute. As the refraction equivalents of all sodium compounds were between 3 and 3·9 less than the corresponding potassium compounds, it was proved that the electro-negative constituent of the salt had the same optical effect no matter with what metal it was combined By taking the refractive equivalent of potassium as 8, and dividing it by the atomic weight (39) of potassium, he obtained for the specific refractive power of that element the number 0·205, and by a similar series of determinations the specific refractive power of sodium, lithium, magnesium, barium, strontium, calcium, zinc, nickel, cobalt, lead, and mercury were ascertained.

BUCHANAN MEDAL.

Sir John Simon, F.R.S.

The Buchanan Medal is presented to Sir John Simon, who may fairly be termed the founder of modern sanitary science.

When, in consequence of the appalling facts relating to the condition of the indigent classes in London which were brought to light by the Sanitary Commission of 1843, powers were conferred by the Legislature on the Corporation for the improvement of so much of the metropolis as is under their control, John Simon was appointed Medical Officer of Health of the city. In this capacity he brought into existence a system of sanitary administration which has served as the model on which similar systems have been organised, not only in Great Britain, but throughout the civilised world.

When, in 1858, the powers of the General Board of Health were transferred to the Privy Council, the knowledge and experience gained by Mr. Simon during his seven years of office in the city were made available for the country at large by his appointment as Medical Adviser of the Government. He held this office for fifteen years, during which he not only energetically and effectually promoted measures of sanitary improvement both in town and country, but initiated a system of scientific investigations to be conducted year by year at the public expense, and it is deeply to be regretted that his plans were not fully carried out.

The funds for this medal were supplied by Sir John Simon's late distinguished pupil, Dr. Buchanan, and it is fitting that the first award should be to the master.

[We are glad to be able to reproduce the portraits of the Royal, Davy, and Buchanan medallists. The portrait of the Copley Medallist, Prof. Albert von Kölliker, will be given on a subsequent occasion in connection with an account of his life and work.]

Report of the Council.

Many of the subjects referred to by the President in his Address at the last anniversary have continued to engage the attention of the President and Council during the past year.

Among the most important duties discharged by the Council is that connected with the consideration of papers communicated to the Society, with a view to ultimate publication in the *Philosophical Transactions* or *Proceedings*. In this duty they have received the most valuable assistance from the Sectional Committees, which were appointed under the Standing Orders mentioned in the last Presidential Address, and which now present a record of their first complete year of working.

In all 116 papers were received between the close of the Session, 1896, and the corresponding period in 1897. Of these, 37 were submitted for publication in the *Philosophical Transactions*, and 70 in the *Proceedings*; and 23 and 75 have been ordered for publication in the two categories respectively.

During the past year 22 papers have been published in the Mathematics and Physics section, and 10 in the Biological section of the *Philosophical Transactions*. The two sections together contain in all 1312 pages of letterpress and 22 plates. Nineteen numbers of the *Proceedings* have been issued, containing 991 pages and 9 plates.

A meeting for discussion in accordance with the regulations contained in the Standing Orders adopted last year was held in March of the current year. The discussion was based on a paper contributed by Sir Norman Lockyer "On the Chemistry of the Hottest Stars"; this, together with some of the principal contributions to the discussion, has been printed in the *Proceedings*.

In pursuance of the resolution of the International Conference on a Catalogue of Scientific Literature, the Council at the beginning of the Session, upon receiving the report of the British delegates to the Conference, and in accordance with the 26th resolution of the Conference, viz.:—

> (26) "That the Royal Society be requested to form a Committee to study all questions relating to the Catalogue referred to it by the Conference, or remaining undecided at the close of the present sittings of the Conference, and to report thereon to the Governments concerned,"

appointed a Committee with full executive powers. This Committee has since been engaged in developing a scheme for the preparation of the projected complete Catalogue of Scientific Literature.

The Committee has held a number of meetings, has devoted much time to the discussion of the difficult questions which arise in devising methods for carrying out so large a scheme as that contemplated by the Conference, and has appointed a number of special Sub Committees for drawing up schemes of classification for the several branches of science.

In view of the resolutions of the Conference, it appeared desirable to establish a (provisional) British Catalogue Committee, which might be consulted by the Committee of the Royal Society on questions relating to the collection and preparation of the material supplied by the scientific literature of Great Britain and Ireland, and might ultimately develop into the National Bureau for the United Kingdom contemplated by the Conference.

An appeal was, therefore, made by the Royal Society's Committee to the chief Societies representative of the sciences to be included in the Catalogue, and to certain important libraries, requesting the appointment of representatives.

Excepting in two cases, in which the nominations are delayed, all the societies and libraries applied to nominated representatives as requested.

At the first meeting of the British Committee thus constituted, representatives of nearly all the sciences included in the invitation attended, and expressed the willingness of the bodies they represented to co-operate in the work of the International Catalogue, though in some cases it was stated that they would not be able to contribute towards the expenses.

The further action to be taken by the various societies towards carrying out the work indicated above, will be considered by committees specially appointed by them for the purpose, and will form the subject of reports to be made to the British Committee.

With the object of keeping the delegates to the International Conference informed as to the work of the Committee, and of eliciting from them suggestions and criticisms upon the matters still under discussion, an *ad interim* statement of the progress so far made in its deliberations has been sent confidentially to all the delegates.

Progress continues to be made with the "Catalogue of Scientific Papers" and with the classified Index thereto.

As regards the supplementary portion of the Catalogue, the transcription of the copy is now approaching completion, and the Council hope that the first instalment of copy may be ready for the printer early in the new year. During the year ending on October 31, about 130 serials have been indexed for the purposes of the Catalogue, representing approximately 774 volumes, and involving the transcription of about 41,000 titles.

Of the classified Index to the Catalogue, about 275,000 slips have now been prepared, of which about 100,000 have been translated. An experimental classification of these slips is being made, in the course of which about 53,000 have already been classified under the eleven divisions sanctioned by the Catalogue Committee. During the past year about 65,000 slips have been prepared, of which about 13,000 have been revised, or translated, as occasion required.

Under the regulations for the administration of the Government Grant Fund, the Council have, upon the recommendation of the Government Grant Committee, made grants amounting to 3115*l.*, in addition to a grant of 1500*l.* made to the Joint Permanent Eclipse Committee out of the Reserve Fund towards the expenses of observing the approaching solar eclipse.

Early in the year, the Council appointed a Committee, called the Government Grant Review Committee, to report upon the manner in which the grants made from the Government Grant have been expended, and on the scientific results thereby attained. The Committee has met, but has not yet reported to the Council. The question of the reappointment of the Committee to make an annual report on the subject referred to them is under consideration.

The Report upon the results of the expedition sent out last year, under the direction of a Committee of the Royal Society, to investigate the structure of a Coral Reef by boring, was presented to the Society in a paper which was printed in the *Proceedings* of February 18, 1897 (vol. lx. p. 502). In that report, the Chairman of the Committee expressed the opinion that a more successful attempt would probably be made from Australia, and the Council therefore heard with satisfaction early in March that the authorities at Sydney would probably be willing to renew the attempt at boring with some assistance in money and influence from the Royal Society. Later, the Council was informed that a second expedition had been despatched from Sydney with the assistance of the Royal Geographical Society of Australasia on the agreement that the core, when recovered, should be sent to the Royal Society, and that all scientific details of the results of the expedition should be reserved for the Royal Society to publish. On the recommendation of the Coral Reef Committee, the balance remaining in hand from last year's expedition was voted in aid of the Australian expedition.

Early in the present month, the Secretaries received a preliminary report from Prof. David, in which he informed them that on September 6 the boring had attained a depth of 557 feet, and in the lower part had pierced more than one mass of coral limestone, one—about 20 feet thick—ending at 550 feet; they have also been informed that the boring was continued after the above-named date, and was still proceeding in generally similar material to that above, at a depth of 643 feet.

The Joint Permanent Eclipse Committee has organised expeditions for the observation of the Total Solar Eclipse in January next; and, at the request of the Committee, applications have been made to the War Office for leave of absence for Capt. Hills, R.E., in order that he may take part in the observation of the Eclipse; to the India Office, for facilities for the landing of instruments free of duty; to the Admiralty, for the conveyance of one of the observing parties to and from their observing station in one of H.M.'s ships; and to the Colonial Office, for facilities for the transhipment of that party from a passenger steamer to the ship of war at Colombo.

All these requests have been acceded to by the authorities.

The Committee appointed last year at the request of Her Majesty's Secretary of State for the Colonies, to investigate the subject of the Tsetse Fly Disease in South Africa has, in the course of the year, through Drs. Kanthack and Durham, and Mr. Blandford, conducted a careful investigation into the disease so far as it can be studied in this country, in subjects inoculated from a dog sent over from South Africa by Surgeon-Major Bruce. The Committee have, at the same time, been in communication with Surgeon-Major Bruce, keeping him informed of the progress of the inquiry here, and offering him suggestions for further investigation in South Africa. The experimental investigations, under Dr. Kanthack, are being pursued at Cambridge, with the aid of a grant of 200*l.*, generously placed at the disposal of the Council by Mr. A. Beit for this purpose. A letter, however, has recently been received from the Colonial Office, stating that Surgeon-Major Bruce's investigations have, for the present, been suspended, and he himself has been directed to return to military duty. The investigations have, so far, not resulted in the indication of any practical preventive treatment of the disease, but the life-history of the hæmatozoon, discovered by Surgeon-Major Bruce and shown by him to be the essential cause of the disease, has been carefully studied, and still presents problems of great interest.

Acting upon the recommendations of the Scientific Relief Committee, the Council has during the year granted 545*l.* to assist scientific men or their relatives in distress. Early in the year the Council found it expedient to codify the practice and original regulations, which had been modified from time to time since the formation of the Scientific Relief Fund, in a series of regulations for the guidance of the Committee in the administration of the fund. The revised regulations will be printed in the new edition of the "Year-Book."

In January the Council received a letter from the Royal Society of Canada urging them to move the Government to give their adhesion to a scheme for the unification of time at sea by the assimilation of the astronomical and civil day, with a view to the necessary alteration being made in the *Nautical Almanac* for 1901. The Council appointed an influential committee to consider the question, and received from them the following report:—

"The Committee report that as there is a great diversity of opinion amongst astronomers and sailors as to the advisability of the adoption of civil reckoning for astronomical purposes, and as it is impossible to carry out such a change in the *Nautical Almanac* for the year 1901, they do not recommend that the Royal Society should at present take any steps in support of the suggested change of reckoning."

Acting upon this advice, the Council have for the present refrained from taking any steps in support of the suggested change of reckoning.

The biennial election to the Joule Studentship was, under the terms of the Trust, placed by the Council last year in the hands of the Académie des Sciences, Paris, which has conferred the award on M. Jules Perrin, Doctor of Sciences, of the École Normale.

Early in the year, the attention of the Council was called to the system of teaching natural science in schools, and a Conference on the subject was arranged between the President and Council and the Fellows appointed by the Society as members of the governing bodies of the public schools. At this Conference an interesting discussion on the subject took place, and a general expression of opinion as to the desirability of attaching increased importance to the teaching of science as a necessary element of education was recorded; but the Council has not at present decided upon taking any further steps in the matter.

About a year ago the President and Council were invited by the Council of the British Association to co-operate in approaching Her Majesty's Government with a view to the establishment of a National Physical Laboratory. At the suggestion of the President and Council, a Joint Committee was formed to discuss the question, and to take action in furtherance of the desired object. This Committee waited upon Lord Salisbury, and laid before him the arguments in favour of the scheme. As a result a Committee has been appointed, with Lord Rayleigh as Chairman, to consider the desirability of establishing such a laboratory, and is now sitting. This Committee recently invited the Royal Society to appoint one or two Fellows to give evidence before the Committee on the subject under reference, and the President and Council have accordingly invited Lord Kelvin and Prof. Oliver Lodge to undertake this duty, which they have accepted.

In May last the Council received a request from Sir Benjamin Stone to nominate representatives upon the preliminary Committee for carrying out a scheme for a National Collection of Photographic Records, and Prof. Lapworth and Prof. Meldola were accordingly appointed to serve on the Committee.

Occasion arose during the past year for the exercise of the functions assigned in 1885 to a Committee designated the Indian Observatories Committee, which, however, has been held to be not a Committee of the Royal Society. The Astronomer Royal having called the attention of the President and Council to the anomalous position of this Committee, it was decided to appoint a new Committee of the Royal Society, to be named the Observatories Committee, to advise the Council on any questions similar to those formerly referred to the Indian Observatories Committee.

Reports have been received from the Kew Observatory Committee (published in the *Proceedings*), the Water Research Committee, and the Meteorological Council.

The Library continues to grow, especially in the section of scientific serials, and, although two book-cases have been added in the saloon, the question of shelf accommodation must soon become a matter for serious consideration. During the past year 10 new serial publications have been added to the 440 which the Society already received at regular intervals by exchange or purchase. Of these 450 serial publications, about

46 are issued in monthly parts
14 ,, ,, weekly ,,
10 ,, ,, fortnightly ,,
10 ,, ,, quarterly ,,

and the remainder at irregular intervals.

Besides these, 53 complete books have been added to the library by presentation or purchase. Among these may be specially mentioned the first volume of the collected papers of the late Prof. J. Couch Adams, two further volumes of the collected papers of Prof. Cayley, Sir Joseph Hooker's "Journal of Sir Joseph Banks," Capt. Lyons's "Report on the Islands and Temples of Philæ," the Procès-Verbaux of the "Conference Internationale des Étoiles Fondamentales de 1896," and the completion of Helmholtz's "Physiologische Optik."

THE ANNIVERSARY DINNER.

In the evening the Fellows and their friends dined together at the Whitehall Rooms, Hôtel Métropôle. The dinner was the most numerously attended of all that have been held in connection with the anniversary meetings of the Society. After the usual loyal toasts had been proposed by the President, Sir John Evans proposed the toast of "Her Majesty's Ministers and the Members of the Legislature," coupling with it the name of the Duke of Devonshire, the Lord President of the Council. In responding, the Duke of Devonshire is reported by the *Times* to have spoken as follows:—

As this is the first occasion on which I have had the honour and pleasure of being present at one of these gatherings, I am not acquainted with the subjects to which the speeches on this occasion are expected to be addressed. But, before accepting the invitation of your President to respond to this toast, I took the precaution of entering into a little negotiation with him, in which I succeeded in obtaining the concession that, whatever happened, I should not be called upon or expected to make a speech upon scientific subjects; and I think the President will bear me out in the statement which I make, that, therefore, I may be dispensed from any attempt to follow Sir John Evans, who has so kindly proposed this toast, into any scientific analogies which he may have been able to discover between the evolution of the human body and the government of the country. In making this confession of incapacity to address you upon scientific subjects, I feel that I am only acknowledging the existence in my own person of a defect which appears to be almost inherent in those who have devoted themselves to the pursuit of politics. I doubt very much whether since the time of Bacon there has ever, with one exception which I will refer to in a moment, been a Minister of the Crown who has been capable of saying anything upon these subjects to an assembly composed of the leading men of science of the day, such as those whom I have the honour of addressing, in words which would be worth their attention. The solitary exception which I can call to my mind is in the person of the present Prime Minister, who, if he had not devoted his powers so vigorously to political and public affairs, would, without doubt, have been an eminent man of science, and who, even now, amidst all his numerous and important avocations, has been able to keep up a not inconsiderable knowledge of the progress and discoveries of many branches of scientific pursuits. Gentlemen, I believe that the divorce which apparently has always existed between the pursuits of politics and science in our country has not been so complete in the case of other nations. We are all of us acquainted with the names of men in many foreign countries who have been eminent in science, and at the same time have, to say the least of it, been conspicuous in politics. Whether that fusion of political and scientific pursuits has always been a success, I do not think is a subject upon which I am called on to enter at the present moment. But, at all events, with regard to our own case, I think it appears to be certain that the calls which the pursuit of politics makes upon the time and strength of any man who desires to attain success in that career are so severe as to leave but little residue for the equally increasing calls upon the strength and time of those who aspire to distinguish themselves in scientific pursuits. But, while I do not look forward to any immediate closer connection between the pursuits of politics and science, I am not by any means sure that in some time not very far distant some greater knowledge and acquaintance with at least the results of scientific investigation and inquiry and research may not come to be a necessary part of the equipment of some portion at least even of our Government. The recent discoveries of science and their practical results have had so profound an influence on the social condition of all the peoples of the world, uncivilised as well as civilised; they have had, and are having, so great an influence upon the industrial progress, and therefore upon the growth or decline of nations, that it is almost impossible that some knowledge at least of the results, if not of the methods, of scientific discovery should become almost as indispensable a part of the training of statesmen as the knowledge of the instincts, the passions, and the interests of the people to which their studies have hitherto been almost entirely, or at any rate mainly, directed. The question whether with advantage the State can more directly interest itself in the direction or assistance of scientific inquiry is one which I have no doubt has been frequently discussed amongst you and upon which, probably, there would be considerable difference of opinion even among those who are assembled here. That is a question which I have no intention of entering upon, but there is a less ambitious object—the object of making some of the main principles of science and a knowledge of the results at least of the discoveries of science more accessible to the main body of the people—which has occupied our attention in recent years. It is also an object which has occupied a greater share of the attention of other nations, and one which, in my opinion, will require and demand greater attention on our part in the future. I hope and trust that at no distant time Her Majesty's Government may be able to make proposals and submit measures to you bearing in

some degree upon the subjects to which I have referred. Among these I may mention such subjects as that of the creation of a teaching University for the City of London. I should not say for the city, but for London itself; and for the whole country some reorganisation of its secondary education, which is the indispensable foundation of any progress towards higher scientific study. I myself entertain a strong conviction that these are subjects of far greater importance than a great many which excite much more general and widespread interest. But strong as my own conviction, or the convictions of my colleagues, upon these subjects may be, I am not here to hold out to you any sanguine hope that we shall be able to induce Parliament to devote to them the attention which these subjects, in my opinion, richly deserve. Certainly we shall not be able to induce Parliament to give them the attention which they demand and require unless we can create in the country a widespread public opinion of their importance and their necessity. I think that many of those I have the honour of addressing, who stand at the head of the scientific professions, may be able in these matters to render great assistance to the Government by guidance, counsel, or advice, and, by helping us, thus assist to create throughout the country a public opinion of the importance of these matters. I think you can assist us in bringing home to the minds of many who have hitherto given, perhaps, an incomplete consideration to these questions the fact that that country cannot prosper which neglects the prosecution of either the higher or the subordinate branches of scientific research, or which is indifferent to the scientific training of those who are destined in the near or even the more distant future to conduct the industrial and commercial enterprises of this Empire. I will not trespass further upon your time except to thank you in the name of my colleagues for the very cordial manner in which this toast has been proposed for your acceptance by Sir John Evans and for the manner in which you have received it.

The American Ambassador in rising to propose the health of the Royal Society, said:—I can only follow at a great distance the example set by his Grace the Duke of Devonshire, and apologise at the beginning for my lack of qualification to address such an assembly as this. I regret that I have not even that smattering of scientific knowledge which would enable me to put on an appearance even of saying anything instructive or amusing. The only reason why I do not stand entirely mute is that I am unwilling by silence to seem indifferent to the great compliment which has been paid me in assigning to me this honourable duty. It is in associations of men like this, in institutions like the Royal Society, and similar bodies in America, of course of more recent date and of narrower resources, that there exists one of the strongest bonds of union that unite the two great branches of our race. They are held together by a common love and pursuit of universal truth, by devotion to the highest interest of mankind, by a kindred passion for light and progress. In your pursuits there is everything that unites and nothing that divides. The results of science are all gain and no loss. The triumphs of war are bought by the tears and anguish of both sides. The success of diplomacy and trade are often attended by the discomfiture of one party. But the whole world is brightened and made more livable by the achievements of a Faraday, a Morse, or a Fulton. The genius of a Lister or a Morton lessens incalculably the whole vast sum of human suffering, and every invention or discovery on either side of the sea—the product of the patient, self-denying labour of any of the scholars of our race, whether it be Lord Kelvin or Edison, Bessemer or Graham Bell, Huxley, Tyndall, or Marsh—is at once thrown into the common stock of the world's intellectual riches, profiting every one and injuring none. It is for this reason that I—although I have no claim to sit among scholars or men of science—am glad to be allowed to come here and pay my humble tribute of profound respect to those eminent men who, under the auspices of this venerable institution, are doing so much to hasten the glad day when all misconceptions and misunderstandings, born of ignorance and prejudice, shall fade away in the light of dawning truth and widening knowledge; when, to use the language of your great poet, who was himself through life a patient and devoted student of science, "Universal Peace" shall

> Lie like a shaft of light across the land,
> And like a lane of beams athwart the sea.

I have the honour to propose the health of the Royal Society, and to couple with the toast the name, honoured and revered in every country upon earth where high genius, devoted to the loftiest purposes, is valued and appreciated—the name of Lord Lister.

The President responded, and afterwards proposed the toast of "The medallists," to which Prof. Forsyth replied. The dinner terminated with the toast of "The guests," proposed by Lord Kelvin, and responded to by Prof. Lewis Campbell.

USEFUL INSECT PRODUCTS.

THE commercial value of the insects from which cochineal, lac, and Japanese white wax are obtained were briefly referred to, by Dr. L. O. Howard, in the course of a short paper on a useful American scale insect, read at the last meeting of the Association of Economic Entomologists. It was pointed out that for many years the cochineal or cactus scale insect, now called *Coccus cacti*, was used as the basis of an important red dye, until practically superseded by the introduction of aniline dyes. In the same way the European Porphyrophora was used in the production of a purple dye. Aside from the dye insects, we have the lac insects, of which a single species, *Tachardia lacca*, produces practically all of the shell-lac, stick lac, and button lac of commerce. This species is Asiatic in its distribution; but in the south-west States, upon the very abundant creosote bush, a lac insect occurs in an enormous quantity, the commercial possibilities of which have not been developed. This is the congeneric species, *Tachardia larreæ* (Comstock). This insect has been known to science only since 1881, but was long prior to that time known to the Indians, who for many years have been in the habit of collecting the scale insects and forming them into more or less elastic balls, which their runners were in the habit of kicking before them as they journeyed from one point to another. There are other species of the same genus inhabiting North America. The third substance of commercial importance derived from scale insects is a pure white wax, which is secreted by the Chinese and Japanese *Ericerus pé-la* and by the Indian *Ceroplastes ceriferus*. On account of its expense, and on account of more or less available substitutes, this wax has not become of great commercial importance in Europe, but is much used in the Eastern countries, both in the making of wax-candles and in medicine. The Chinese wax is said to have ten times the illuminating power of other waxes. It is a beautiful wax, resembling beeswax in its chemical composition more nearly than the vegetable waxes, and is clear white in colour. Dr. Howard calls attention to the fact that in the far south-west of the United States there is a wax insect (*Cerococcus quercus*) which apparently needs careful investigation from the commercial point of view. Three species of oak are recorded by Prof. Comstock as offering food for this insect, viz. *Quercus oblongifolia*, *Q. undulata* variety *wrightii*, and *Q. agrifolia*. Dr. Howard recently received specimens of the insect from Mesa Grande, California. They were not sent in position on the twigs, but had been removed from the twigs, and compressed together by hand into a more or less pliable lump, somewhat resembling a lump of india-rubber, but not possessing the same elasticity. The substance, it is remarked, makes an admirable chewing gum, as it takes and retains flavours better than other gums. Part of it has been proved by chemical analysis to be a true wax, and part resembles rubber in its physical properties. The product is not only interesting from a chemical standpoint, but it may prove to be also of economic value, as the supply is well-nigh inexhaustible. By directing attention to these products of potential importance, Dr. Howard demonstrates the commercial uses of entomology.

THE RAINFALL OF SOUTH AFRICA.

A SHORT time ago the Meteorological Commission of Cape Town placed in the hands of Dr. Alexander Buchan the rainfall statistics obtained at 278 stations in Cape Colony during the ten years 1885–1894, in order that he might analyse and discuss them. Dr. Buchan has now completed his task, and the results are given in a publication just received from the Meteorological Commission. The report contains sixteen maps printed in different shades of blue to exhibit the rainfall in South Africa (from lat. 25° to 35° S.) for every month of the year, the maximum annual rainfall, the minimum rainfall, the mean annual rainfall, and the range of mean annual rainfall. All the infor-

mation which the statistics are capable of affording has thus been extracted from them, and is shown graphically upon this series of maps.

In a brief introduction to the tables and maps, Dr. Buchan refers to a few points of interest to meteorologists and physiographers. It appears from this, and the map of mean annual rainfall, that the annual distribution over South Africa, to the north of the latitude of Clanwilliam, steadily increases from west to east, the amount on the Atlantic coast falling short of five inches a year, whereas on the east coast, for some distance to the north and south of Durban, it exceeds forty inches. From Philadelphia, a little to the north of Cape Town, all along the south and south-eastern coast (with the exception of a small portion from Cape Agulhas to Mossel Bay), and for some distance inland, the annual rainfall exceeds twenty inches. These southern slopes appear to be, longitude for longitude, the best watered portions of South Africa.

Dr. Buchan studied the statistics with reference to the sunspot period; and with reference to the subject reports as follows;—

Sunspot Period of the Rainfall.

"In order to see what connection may be between the sunspot period and the rainfall of Cape Town, the annual amounts are thus arranged:—

"Table showingthe difference of each year's rainfall from fifty-four years' average of 25·82 inches.[1]

Year of period	1	2	3	4	5	6	7	8	9	10	11
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1842–43 ...	...	...	...	...	...	...	...	..	...	**·45**	·99
1844–54 ...	7·05	4·91	3·31	3·43	2·56	1·20	**7·65**	5·52	2·60	4·59	5·76
1855–65 ...	1·24	6·34	3·78	3·54	**10·91**	**3·31**	·36	**6·18**	·21	6·90	7·14
1866–76 ...	6·61	2·87	5·86	**6·52**	**2·24**	5·70	**3·51**	2·05	**·38**	·10	**·83**
1877–87 ...	**9·75**	**15·21**	7·07	8·11	·21	**3·49**	**6·24**	**2·47**	**2·10**	**2·03**	2·74
1888–94 ...	**10·24**	**5·16**	**·52**	**4·48**	**15·10**	2·40	3·27	...	...	...	...
Means ...	**1·02**	**1·25**	4·90	·42	**5·10**	**·50**	**2·75**	**·27**	·08	1·82	3·16
Means Bloxamed	·30	·88	1·36	·07	**1·73**	**2·78**	**1·17**	**·98**	·54	1·69	1·32

"The individual years' rainfall shows sudden transitions in amount from year to year. Thus 1877 and 1878 show respectively 9·75 inches, and 15·21 inches of excess above the average; whereas the two following years, 1879 and 1880, show 7·07 inches and 8·11 inches of deficiency. These two pairs of consecutive years are, further, the greatest departures above and below the average annual rainfall of the whole fifty-four years.

"The means of the eleven-year period have been 'bloxamed' thus, 1st year $= \frac{11+1+2}{3}$, 2nd year $= \frac{1+2+3}{3}$, and so on. The smoothed curve thus obtained is a remarkable one. The rainfall is above the average in the fifth, sixth, seventh, and eighth years of the sunspot period, but under the average in the other years. The curve further shows two maxima and two minima. The smaller maximum occurs on the first year, thence the rainfall diminishes to the smaller of the two minima on the third year; then gradually rises to the principal maximum, 2·78 inches above the average, on the sixth year; and thereafter steadily falls to the principal minimum, 1·69 inch below the average, on the tenth year. There is thus a difference of 4·47 inches between the annual rainfall of the wettest and driest years of the sunspot period. The steadiness of the increase and decrease of the rainfall during the period is the most remarkable feature of the curve. It must, however, be noted that the extreme irregularity of the annual amounts from year to year cannot be said to hold out a hope that the cycle can be turned to practical account in forecasting dry and wet years."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. F. Harrison (New Coll.) has been appointed Examiner in Mechanics and Physics, Mr. W. W. Fisher (C.C.C.) in Chemistry, and Mr. C. H. Barks (Camb.) in Botany, for the preliminary examination in the Final Honours School of Natural Science.

[1] The heavy type indicates an excess or plus amount, and the light, a deficiency or minus quantity as compared with the mean.

Convocation has directed that 600*l*. a year be paid to the Visitors of the University Observatory for its use for the next five years, beginning January 1, 1898.

The following grants have been made to the Botanical Department: (1) for the Herbarium, Library, and Museum such a sum as will, with the Fielding Fund, make up 400*l*. a year; (2) 650*l*. a year for the Botanic Garden. The grants extend over the years 1898–1900.

The Professor of Chinese, James Legge, died on Monday at his residence in Oxford.

Mr. J. O. Griffiths, of Llandovery College, has been elected to a Mathematical Scholarship, and Mr. O. T. Falk, of Rugby, to an Exhibition at Balliol College. Mr. E. W. Shobridge, Bradford Grammar School, has been awarded a Mathematical Scholarship at Queen's College, and Mr. F. R. Sandbach to one at Corpus Christi College. At Hertford College, Mr. H. A. Brown, of Plymouth College, has obtained a Mathematical Scholarship, and Mr. R. Cambridge an Exhibition.

Mr. G. Priestley, of Eton College, has been elected to a Natural Science Scholarship, and Mr. S. Douglas, of Wyggeston School, Leicester, to an Exhibition at Christ Church.

THE Russian Government has granted 400,000 roubles for the construction of a chemical laboratory at the Polytechnic Institute at Riga.

A COURSE of ten Thomson Lectures on Magnetism will be given at the Free Church College, Aberdeen, by Prof. J. A. Ewing, F.R.S., from December 9–22.

DR. F. STANLEY KIPPING, F.R.S., Lecturer and Assistant in the Chemical Research Laboratory of the Central Technical College, has been appointed to the Professorship of Chemistry in University College, Nottingham.

PRESIDENT SETH LOW, at the request of the trustees of Columbia University, has withdrawn his resignation, which was presented before the election in order to leave him unembarrassed in the canvass; he will, therefore, continue to preside.

WE learn from *Science* that the Technical Institute in Munich has been given by the Government 175,000 marks for enlarging the electro-technical laboratory, 150,000 marks for the erection of a laboratory for the agricultural station, and 170,000 marks for enlarging other buildings.

THE Root Hall of Science and the Benedict Hall of Languages of Hamilton College were dedicated a few days ago. The former, which cost 31,000 dollars, was the gift of Mr. Elihu Root, and the latter, which cost 30,000 dollars, of Mr. H. H. Benedict, both of New York City.

THE Council of the College of Preceptors have arranged a number of lectures to be delivered between January 4 and January 14, and visits to Educational Institutions, for teachers (especially Secondary Teachers), who will be in London at that period. Among the subjects of the courses of lectures are the principles of class teaching, by Mr. J. J. Findlay; and the teaching of science, by Dr. C. W. Kimmins. This course will have special reference to the Headmasters' Association's syllabus of physics and chemistry. An address on eyesight in relation to school life, will be given by Dr. W. S. Colman; and one on circulating school museums, by Mr. E. Howarth. There will also be an exhibition of geographical lantern slides, specially prepared for the Geographical Association, by Mr. B. B. Dickinson.

AT the annual meeting of the Scottish Association for the promotion of Technical and Secondary Education, held in Edinburgh on Saturday, the President, Lord Reay, delivered an address on the necessity of paying more attention in this country to organising and systematising technical education. In the course of his remarks he said that though the Victorian era had been rich in men of the highest scientific eminence, other nations not possessing men of equal eminence had enriched themselves by the teaching of the men who filled such glorious pages in our history. In chemistry, in physics, in electricity, in geology, in astronomy, the most illustrious names of Scotsmen and Englishmen could be mentioned, but when it came to the adaptation of their teaching in the school, in the workshop, on large landed estates, they had to go to Germany, to the United States, to Switzerland, and to Belgium. Our system of education ought to

be worked on better lines. No spasmodic efforts here and there to form science classes, but technical schools which led to technical colleges, on a carefully graded system, were needed. The Education Department would have to determine clearly the lines of demarcation of the various forms of education which it would support. In the United States, Germany, France, and Switzerland, public money was ungrudgingly given to technical schools, and there was no reason why in this country there should be so much hesitation. The cause of the success and progress of continental industry was due to the keen sense of competition and to the widespread conviction that all production must be placed on a scientific basis. Science there was not considered as a luxury, but as a powerful agent of economic production. The sooner we realised that our very existence as an industrial nation was threatened the better.

THE opinions expressed by Prof. Priestley Smith in a pamphlet on the "Aims and Methods of Education" (Cornish Brothers, Manchester), just received, are accepted by the majority of people who have given thought to educational systems. The ordinary middle-class parent is content to know nothing about the efficiency of the instructors in the schools to which he sends his children. Happily, the times are not without signs of the growth of a healthy interest in the subject of rational education, and we welcome every publication which will encourage its development. All of us are of much the same opinion as regards the futility of learning by rote, and the truly educational value of a kindergarten system of education for the young. A kindergarten may be described as a place where children learn by natural instead of unnatural methods, and consequently acquire more realknowledge than by any other system. But not every school that is called a kindergarten justifies the title, for in many of these schools, as in many private schools for the middle-class, qualification to teach is often a secondary matter compared with local influence. The elementary school teacher must show himself qualified to teach before he can be recognised by the Education Department, but we have not yet reached the stage of educational progress when the master of a private school must produce similar credentials. When these anomalies are destroyed we may perhaps hope for the establishment of a rational system of education, for we shall then have the men to put it into effect. Prof. Smith says many hard but true things with regard to the classical veneer which effectually covers up natural tendencies in the public school. "The follower of nature," he remarks, "in education, adopts a different system. He believes less in books, which supply information ready cut and dried, than in mental exercises carried on in class by question, discussion, and demonstration. He helps the boy to observe and compare examples, to discover likenesses and differences, and to arrive at rules and principles by inferring them for himself. He aims at *self-training*, and studies the art of promoting it. He declares that this system arouses a greater activity of interest in the boy, and makes of his mind an instrument for observation and reflection rather than a storehouse." This is the system of education we should encourage, because it is the one which will most benefit the child, the country, and the race.

SCIENTIFIC SERIALS.

Bollettino della Società Sismologica Italiana, vol. iii. N. 3.—An electric seismoscope of double sensitiveness, by G. Agamennone.—An elastic pendulum for mechanical action, by C. Guzzanti.—Notices of earthquakes recorded in Italy (February 18–March 20, 1897), by G. Agamennone, the most interesting being those of distant, but unknown, earthquakes on February 19–20 and March 2.

N. 4.—The earthquake of Kishm (Persian Gulf) of the night of January 10–11, 1897, by G. Agamennone. A correlation of some records of a previously unknown earthquake obtained at European observatories between 9.15 and 9.32 p.m. (Greenwich mean time) on January 10, with an earthquake occurring at 9.30 (?) in the island of Kishm, but the times are too discordant to enable the velocity to be determined.—Summary of the principal eruptive phenomena in Sicily and the adjacent islands during the half-year January–June 1897, by S. Arcidiacono.—Condition of the central crater of Etna from the second half-year of 1895 to the first half-year of 1897, by A. Riccò.—Notices of the earthquakes recorded in Italy (March 20–April 27, 1897), by G. Agamennone, the most important being the Umbrian earthquake of March 21–22, the Roman earthquakes of April 3, the Lucano earthquake of April 16, and the Abruzzi earthquake of April 26–27.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 25.—"On the Geometrical Treatment of the 'Normal Curve' of Statistics, with especial Reference to Correlation and to the Theory of Error." By W. F. Sheppard, LL.M., formerly Fellow of Trinity College, Cambridge.

The object of the paper was, in the first place, to simplify and extend the treatment of normal correlation as expounded by Francis Galton and Karl Pearson; and in the second place to obtain general formulæ in the theory of error, and to apply them to questions which arise in relation to normal distributions and normal correlation. The method was, throughout, elementary, the use of the differential and integral calculus being avoided, though geometrical infinitesimals were to a certain extent employed.

Physical Society, November 26.—Mr. Shelford Bidwell, President, in the chair.—Mr. Rollo Appleyard read a paper on the failure of German-silver and platinoid wires. The mechanical defectiveness, and the consequent electrical instability of alloys used for electrical wires, may be discussed from two points of view: (1) as to the constitution and metallurgy of the alloy; (2) with regard to the subsequent treatment and environment of the wire. In stating the case, the author gives instances of the failure of German-silver and platinoid wire that have occurred among several thousands of resistance-coils distributed over widely different latitudes. In periods of time, varying from six weeks to several years after manufacture, the wire on some of the bobbins became brittle and broke, not only on the outer layers, but also within the coils. The towns where the faults appeared are all within the tropics, and included nearly within the isotherm of 25° C. Other coils, of nominally the same material, manufacture, and environment, have retained their original good condition. It follows that metallurgical differences exist between different samples of the same nominal quality of alloy. Examples are given to prove that failure sometimes occurs with platinoid through which no electricity has passed. Provided that the wire is good, the effect of environment is almost insignificant, *i.e.* the question is one of metallurgy, rather than of instrument-making. The author introduces a distinction in regard to brittleness. He discriminates between "primary" and "secondary" brittleness. "Primary" brittleness is characteristic of certain alloys (for instance, of gold-lead, or of gold-bismuth) from the moment of their solidification. But the brittleness of German-silver and of platinoid is of a different order; it is a subsequent phenomenon. "Primary" brittleness is thus an accident of birth, and "secondary" brittleness is a disease that develops with age and circumstance. The fracture of bad specimens of German-silver and platinoid shows patches of dark metal, crevices, and fissures. It may be supposed that, during the process of cooling, "liquation" occurs—the metals that first solidify, rejecting yet molten portions, as ice rejects foreign matter. Consequently, the strength of the final alloy varies from point to point of its mass, and in passing afterwards through the die, the weaker portions give way, and the general structure is loosened: moisture can then intrude through the capillary channels. At all fissures and crevices the electric current produces undue heating; this accounts for the failure of resistance-coils on arc-light and other circuits. As regards the protection of coils against moisture, paraffin-wax is of no use whatever; it is highly absorbent. Shellac varnish is greatly to be preferred. Ebonite does not seem to have any deteriorating effect, but it may be well to keep the alloys out of actual contact with it. In conclusion, Mr. Appleyard expressed a hope that British metallurgists would give electrical alloys special consideration. Already, British cable-manufacturers are importing thousands of tons, annually, of sheathing-wire from Germany; this is sufficiently to be regretted; he had good

reason to know that instrument-makers were beginning to get the wire for their resistance-coils also from Germany. He had not enough experience of manganin to say whether that material would stand rough service in the tropics. Prof. Ayrton said the paper had raised the extremely interesting question of the permanency of metals used for resistance-coils. Some time ago he had immersed bare platinoid wires in running water in metal tanks, and the wires all broke into short pieces. He thought, at the time, this might be due to electrolysis. On another occasion he had found that by raising the temperature of platinoid to a dull-red heat in the air, by an electric current, any acquired faults in the wire were corrected, and the original resistance and flexibility were restored. Even when such metals are in good condition, the resistance temperature curve does not return upon itself; it encloses a loop, indicating two distinct values for resistance at each temperature. He had been told by Dr. Muirhead that coils intended for hot climates should be enclosed in air-tight metal cases. English manufacturers were still dubious in regard to manganin. In 1892 he had twenty coils of this material, each of a thousand ohms; the wire was silk covered. There were 2000 volts between the terminals. Their resistance had certainly not changed by 1 in 1000, although there was some amount of vagueness regarding the fifth figure, which might be due to molecular alteration, for they were heated more than was good for resistance coils. He confessed that this manganin had come from Germany. Dr. S. P. Thompson mentioned an alloy that was proposed in Germany under the name of "Constantin." He would like to know whether any information could be obtained as to the employment of cast-iron wire. It was a metal that in some respects commended itself. He had observed the failure of some German-silver coils, but he had generally attributed it to rough handling. Mr. W. Watson referred to the recent work done at the Reichsanstalt with regard to German-silver and platinoid. It was there found that all alloys containing zinc were liable to erratic change of resistance, and were unsuitable for standard coils. Moreover, even the slight amount of zinc introduced into manganin during soldering with soft solder robbed that alloy of its constancy. Silver solder, containing 75 per cent. of silver, should be employed for manganin. If Prof. Ayrton's coils were soldered with soft solder, that was sufficient to account for the change in the fifth figure. Shellac varnish was undoubtedly the best protection for coils. Absolute alcohol should be used as the solvent, and the coils should afterwards be heated for some hours at 140° C. If a heating-current was passed through German-silver or platinoid coils immersed in water, the general result was to produce brittleness.—Mr. Watson then described a thermostat which he had contrived for drying the coils after applying the shellac varnish. A hot-air oven contains a thermometer with a platinum contact at the 140° mark, and an 8 candle-power lamp. The thermometer is in circuit with a relay actuating a mercury-key for the 8 candle-power lamp. The key consists of two mercury-cups, and a corresponding U-piece of copper, inverted, one limb to each cup. It is important to keep the heating-circuit always made; for this purpose a 32 candle-power lamp is permanently connected between the two cups.—Prof. Perry then read a note on a question in thermo-dynamics, arising from correspondence that had taken place between himself, Prof. Ramsay, and Mr. Rose-Innes, with regard to a paper in the *Roy. Soc. Trans.* Mr. Rose-Innes replied.—The President proposed a vote of thanks to the authors, and the meeting adjourned until December 10.

Mathematical Society, November 11.—Prof. Elliott, F.R.S., President, in the chair.—The President briefly referred to the recent decease of Lieut.-Colonel J. R. Campbell, who had served on the Council, and rendered signal service to the Society by his liberal gift of 500*l.* to its funds.—The Treasurer gave an abstract of his report, and, in the course of his remarks, pointed out that the publications of the Society had of recent years grown to such an extent as to tax its utmost resources, and that, were it not for the help of the funds munificently established many years ago by Lord Rayleigh, and more recently by the late Lieut.-Colonel Campbell, the Society would be compelled to materially restrict its sphere of activity.—The ballot having been taken, the President announced that the gentlemen whose names were given in NATURE (October 21) had been duly elected to serve on the Council for the ensuing session.—The following communications were made: On an extension of the exponential theorem, by J. E. Campbell; the integral $\int P_n^2 dx$, and allied forms in Legendre's functions, between arbitrary limits, by R. Hargreaves; on the Poncelet polygons of a Limaçon, by Prof. F. Morley; the calculus of equivalent statements (No. 7), by H. MacColl; the character of the general integral of partial differential equations, by Prof. Forsyth; note on Bessel functions, by H. M. Macdonald.

Geological Society, November 17.—Dr. Henry Hicks, F.R.S., President, in the chair.—The geology of Rotuma, by J. Stanley Gardiner. The author described the relationship of the island of Rotuma (situated in lat. 12° 30′ S., long. 177° 1′ E.) to the adjoining isles. It is almost separated into two parts, which are united by a narrow neck of sand. The interior is composed of volcanoes, which have emitted lavas and fragmental rocks. Around the volcanic rocks are stratified deposits composed of sea-sand with volcanic fragments. These are partly denuded, and are mantled round by coral-reef and beach sand-flats. A remarkable cavern in the lava of Sol Mapii, with lava-stalactites, was described; there is a similar cavern in Au Huf Huf. An account of the prevalent meteorological conditions was also given. In an appendix by Mr. H. Woods, some of the rocks were described. They consist of olivine-dolerites and basalts and associated fragmental rocks.—A geological survey of the Witwatersrand and other districts in the Southern Transvaal, by Dr. Frederick H. Hatch. After giving an account of the physical characters of the area, the author proceeded to describe the various rocks, referred to (1) the Karoo system; (2) the Cape system; (3) the Primary or Archæan system. The Archæan rocks protrude in a few places through the sedimentary beds, which form the greater part of the area, and consist of an igneous complex of rocks of varied composition. The Cape system is capable of division into five distinct series:—

UPPER BEDS.	Magaliesberg and Gatsrand series; alternating quartzites, shales, and lava-flows. 16,000 to 20,000 feet.
	Dolomite and cherts, thickly bedded. 6000 to 8000 feet.
	Black reef; a bed of quartzite and conglomerate, 20 to 50 feet, and Klipriversberg amygdaloid; a basic volcanic rock, 5000 to 6000 feet.
LOWER BEDS.	Witwatersrand beds; sandstones and conglomerate (in part auriferous). 11,000 to 15,000 feet.
	Hospital Hill series; quartzites and ferruginous shales. 8000 to 10,000 feet.

The Karoo formation is represented by the coal-measures of Vereeniging and the district south of Heidelberg, and by the measures of other coal-areas. They have furnished plants which Mr. Seward refers to in a note as being of Permo-Carboniferous age. The age of the Cape system is doubtful. The Upper beds rest unconformably on the Lower ones, and if the latter be of Devonian age, as has been inferred, the former may represent the Lower Carboniferous rocks. In the discussion which followed the reading of the paper, the President asked whether there was any fossil evidence to show the age of the beds under those of Permo-Carboniferous age. The unconformities were important, and might indicate that there were rocks in the area older than those of Palæozoic age. Would it not be better to avoid using the term "Primary" for crystalline rocks suggested to be of "Archæan" age? Mr. C. Dawson pointed out the great lithological resemblance of the specimens on the table from the Hospital Hill series to some of the fluviatile rocks of the English Wealden group; particularly to the lower beds of the Hastings sands and Ashburnham group. The Cape series, of course, was a much older formation and had suffered change, but the rocks of the Hospital Hill series appeared to have suffered least. Prof. Le Neve Foster said that he considered that all persons interested in gold-mining were much indebted to the author for his very valuable contribution to our knowledge of the geology of a great gold-bearing region. He desired information upon two points: (1) whether the conglomerate-beds on the southern side of the synclinal are as rich in gold as those which have been so largely worked on the north side; and (2) what surface-indications guide the prospector in searching for the outcrop of the beds. Is their existence indicated by quartz-pebbles on the surface, or by ferruginous outcrops, or what? In conclusion, he complained of the use by the author of the expression "mineralisation of the conglomerate"; he wished in season and out of season to protest against this use of the word

"mineralisation" Mr. W. H. Merritt said that what he thought of special interest was the mode of occurrence of the gold in these conglomerates. He said that this showed that auriferous solutions may occur in a very unexpected manner, and in very unexpected places; and in confirmation of this he alluded to a locality in British Columbia where gold occurred, and was worked in deposits of cupriferous pyrrhotite containing virtually no free quartz and occurring chiefly in gabbro. The Rev. J. F. Blake and Dr. J. W. Gregory also spoke. The author, replying to the President, admitted that in describing the ancient crystalline rocks he had used the term "Primary" indiscriminately with "Archæan." He agreed that it would perhaps be better to discard the former, and to use the latter term in preference. With regard to the age of the Cape formation, he had pointed out in the paper that the Witwatersrand beds were probably correctly correlated with the Table Mountain sandstone, and that the latter was underlain by the Bokkeveld shales, in which characteristic Palæozoic (Devonian) fossils had been found. Replying to Prof. Le Neve Foster, he instanced the Nigel Mine as one that had been opened up in payable ore on the south side of the synclinal. There was nothing to indicate which of the conglomerate-beds might carry gold, short of taking samples for panning or assay. He saw no objection to the use of the word "mineralisation" to indicate a secondary impregnation with mineral matter. He was glad to find that Dr. Gregory confirmed him in the idea that the Dwyka conglomerate was a volcanic breccia, and consequently indicative of volcanic activity.—Observations on the genus *Aclisina*, de Koninck, with descriptions of British species, and of some other carboniferous gastropoda, by Miss J. Donald, of Carlisle. The author made some preliminary observations on the genus *Aclisina*, and considered it advisable to regard *A. pulchra* as the type of the genus, while the so-called *A. striatula* must be placed among the *Murchsoniæ*, and *A. nana* is placed in a new genus.

Entomological Society, November 17.—Mr. R. McLachlan, F.R.S., Vice-President and Treasurer, in the chair.—Mr. Selwyn Image exhibited male examples of *Pieris brassicæ*, with a black spot on the disc of the forewings. They were bred from larvæ found on *Tropæolum* at Lee, N. Devon, and six out of ten males showed this variation. He also showed a dark aberration of *Vanessa urticæ*, taken at Copthorne in Sussex, and two fine specimens of *Plusia moneta* taken at Valerian, near Balcombe, Sussex.—Mr. M. Burr exhibited three new species of Rumanian Orthoptera in illustration of a later communication.—On behalf of Mr. T. D. A. Cockerell, of Mesilla, New Mexico, two specimens of *Synchloe lacinia* from that locality were exhibited to show the remarkable forms of variation found in individuals occurring at the same time and place and on the same flowers.—Mrs. Nicholl communicated a paper on the butterflies of Aragon, and Mr. Burr a list of Rumanian Orthoptera.—Mr. Tutt read a paper entitled "Some results of recent experiments in hybridising *Tephrosia bistortata* and *Tephrosia crepuscularia*."

Royal Meteorological Society, November 17.—Mr. E. Mawley, President, in the chair.—Mr. R. H. Curtis gave the results of a comparison between the sunshine records obtained simultaneously from a Campbell-Stokes burning recorder and from a Jordan photographic recorder. The Campbell-Stokes recorder consists of a sphere of glass, four inches in diameter, supported in a metal zodiacal frame. A card being inserted in one of the grooves according to the season of the year, the sun when shining burns away or chars the surface at the points on which its image successively falls, and so gives a record of the duration of bright sunshine. The Jordan recorder consists of a cylindrical box, on the inside of which is placed a sheet of sensitive cyanotype paper. The sunlight, which is admitted into the box by two small apertures, acts on the paper, and travelling over it by reason of the earth's rotation, leaves a distinct trace of chemical action. In an improved pattern two semi-cylindrical boxes are used, one to contain the morning, and the other the afternoon record. The Campbell-Stokes instrument gives a record of sun heat and the Jordan instrument a record of sun light; and whilst it is probably true that, as a rule, the burning and chemical effects vary directly with the brightness of the sun's rays, yet it by no means follows that the conditions which will produce the most active chemical action must necessarily and always be those most favourable for burning. It has been the opinion of most observers that the photographic instruments yield a larger record than those of the burning type. In order to set the matter at rest the Council of the Royal Meteorological Society determined to institute a comparison between the Campbell-Stokes and the Jordan recorders, which should thoroughly test the capabilities of the two instruments, and at the same time afford trustworthy data for determining how far the records yielded by the one may be accepted for comparison with those obtained from the other. These simultaneous observations were carried out by Mr. E. T. Dowson, at Geldeston, near Beccles, and extended over a period of twelve months. The records were sent to Mr. Curtis for tabulation, who gave the results of his examination in this paper. After describing the methods adopted for the measurement of the records, Mr. Curtis drew the following conclusions from the figures: (1) In the case of the Campbell-Stokes instrument the records are capable of being measured with a very fair degree of accuracy. (2) The records of the Jordan instrument afford room for much greater difference of opinion as to what ought to be tabulated, and consequently measurements of the Jordan curves are open to considerably more doubt than are measurements of the Campbell-Stokes curves. (3) When the whole of the photographic trace which can be distinctly seen, but including portions of it which are decidedly faint, has been carefully measured, the amount will approximate sufficiently to that of the Campbell-Stokes instrument to allow of records obtained from both forms of instrument being compared *inter se*. From an examination of the records at other stations it appears that on some occasions the instruments have begun to record within thirteen minutes after sunrise, and has continued up to ten minutes before sunset. Mr. Curtis concluded his paper by calling attention to various defects in the adjustment and working of the instruments, and pointed out how these might be overcome. After the paper had been read, an interesting discussion ensued as to the merits of the respective sunshine recorders.

Linnean Society, November 18.—Dr. A. Günther, F.R.S., President, in the chair—The President announced that since the close of last session they had been so fortunate as to receive from Prof. G. J. Allman, a former President of the Society, a portrait of himself painted by Miss Busk, whose portrait of her late father was now hanging near it. It was an excellent likeness, and he was sure it would be highly valued. He moved that a vote of thanks be recorded for the presentation, and this was unanimously agreed to.—Mr. Alan F. Crossman exhibited photographs of a fasciated lily (*Lilium auratum*), on which some information was given by Mr. A. D. Michael.—Mr. R. Morton Middleton exhibited and made remarks on some ants received from Ephesus. These had been referred to in a previous communication as being made use of in Asia Minor for the purpose of holding together the edges of incised wounds by means of their strongly-hooked and sharp mandibles (*Journ. Linn. Soc.*, *Zool.* vol. xxv. p. 405). The species was now identified as *Cataglyphus viatica*, Fabr. Mr. Thomas Christy gave some additional information resulting from inquiries he had made of foreign correspondents.—Mr. J. E. Harting exhibited a specimen of the great black woodpecker (*Picus martius*), lately received from Colonel W. C. Dawson, of Weston Hall, Otley, Yorkshire, where it had been shot in his presence by a friend on September 8. It was shown that this could not be the bird which had recently been lost from the Zoological Gardens, since the latter did not escape until October 9. Allusion was made to the numerous records of the occurrence of this species in England, some of which at least seemed worthy of credence, since the recorded specimens had been obtained, and were preserved in the possession of trustworthy persons. Mr. Howard Saunders expressed the opinion that there was no sufficient ground for including *Picus martius* in the list of British birds, as from its partiality for pine forests and its stationary habits, it was not likely to be a voluntary visitor to this country. The President remarked that the perfect state of plumage of the specimen exhibited was satisfactory evidence of its not having recently escaped from captivity; and that the late Lord Lilford, the year before his death (which occurred on June 17, 1896), had two black woodpeckers in his aviary in Northamptonshire, and in consequence of their ailing in health, had given them their liberty. It seemed possible that one of these might be the bird lately shot in Yorkshire.—Mr. J. E. Harting also exhibited in the flesh a hybrid pheasant and black grouse, which had been received that day from Shropshire. In appearance it precisely resembled a similar hybrid of which a coloured figure is given in early editions of White's "Selborne."—On behalf of Mr. Leonard Lush, of Stonehouse, Gloucestershire, three white

partridges (*Perdix cinerea*) were exhibited, which had been shot by him on the Berwyn Mountains in Wales early in October last. It was remarkable that in the covey, which consisted of nine birds, no less than five of them were white, four only being of the normal colour.—Mr. Hamilton Leigh exhibited the skull of a red deer recently shot by him in Scotland, in which there was a singular distortion of the pedicel, resulting from an ancient fracture of the left temporal bone.—A paper by Prof. A. Dendy, of Canterbury College, N.Z., was read, on *Pontobolbos Manaarensis* (gen. et. spec. nov.), a problematical cushion-shaped marine object, measuring from 13 to 36 mm. in transverse diameter, found attached to rocks in shallow water in the Gulf of Manaar, of which he had received fifteen specimens among a collection of sponges sent to him by Mr. Edgar Thurston, Superintendent of the Madras Museum. The object was found to be concentrically laminated and to contain calcareous material, and a "ground-substance," the various microchemical reactions of which were carefully described, and which, if protoplasmic, yielded no traces of nuclear structures. Minute algæ were also detected, and in the deeper layers foreign particles in the form of sand-grains. The predominant component was found to be a dense feltwork of minute filaments, for the most part radially arranged and destitute of contents, which after prolonged study the author had come to regard as bacterial. Comparison was instituted between these filaments and certain Schizophyta, and between the entire object and certain calcareous algoid "pebbles," described by Murray, from Michigan and elsewhere, as also between it and the gigantic Rhizopod *Loftusia* (Carp. and Brady); and as an admittedly tentative conclusion, the author, anxious to record the existence of so remarkable an object, inclined to the belief that it may be a symbiote involving some gigantic rhizopod undetermined and a bacterial organism. Prof. Howes, in reading the paper, submitted some microscopic sections of the object which had been made at South Kensington from material sent him by the author. He pointed out that spicules apparently of sponges could be detected among the foreign particles; and remarked that to him and his colleagues at the Royal College of Science it appeared that while bacteria were present, algal filaments were overwhelmingly predominant, and that the evidence for the supposed presence of a gigantic rhizopod was exceedingly slender. In this criticism he was supported by Mr. George Murray, who had also examined the material, and who, after considering the comparison with the afore-mentioned "pebbles," put forward a suggestion of probable similarity to the algal "pseudomorphs" apparently parasitic on sponges, first recorded by Carter in the *Annals and Mag. Nat. Hist.* for 1878.—Mr. F. Chapman read a paper on *Haddonia*, a new genus of Foraminifera, from Torres Straits. He explained, with the aid of lantern-slides, that *Haddonia* is a calcareo-arenaceous type, of the subfamily *Lituolinæ* (of Brady).

CAMBRIDGE.

Philosophical Society, November 22.—Demonstration of the influence of uranium rays upon the formation of clouds, by Mr. C. T. R. Wilson. The effect was clearly seen by the members of the Society present.—Exhibition of models of the regular and semi-regular solids, by W. W. Taylor. Mr. Taylor exhibited and explained the construction of a large number of solids, the star solids having very various forms.—Partial differential equations of the second order, involving three independent variables and possessing an intermediary integral, by Prof. Forsyth. The author discussed the theory of these equations and developed it to the same extent as the corresponding theory in the case of two variables had already been developed. In particular, he dealt with the equations which are the extension of the Monge-Boole form; and he obtained a class of equations which is the generalisation of the class discovered by Goursat: they possess an intermediary integral, though not of the general functional character appropriate to the Monge-Boole equation.—The harmonic expression of the daily variation of solar radiation, and the annual variation of its coefficients, by Mr. R. Hargreaves.—On the fifth book of Euclid's elements, by Dr. M. J. M. Hill.—Electrification of newly prepared gases, by Mr. J. S. Townsend. This paper contained an account of experiments which were applied to find the charge on the individual carriers of the electricity in charged gases, and also the velocity of the carrier when acted on by an electric force. The results of experiments on diffusion show that the charge will not diffuse through porous earthenware with the gas.—On a chemical effect produced by the impact of kathode rays, by Prof. J. J. Thomson and Mr. Skinner. Aluminium is rapidly evaporated from the kathode by an electric discharge in a highly exhausted vacuum tube in which air has been replaced by mercury vapour. The metal is condensed over the walls of the tube in the form of a bright mirror. An iron kathode gives a similar mirror in a mercury vapour discharge tube. When the aluminium coating is dissolved off the wall of the bulb by hydrochloric acid a gelatinous membrane remains which gives the reactions of silica. When potassium vapour is used the glass opposite the aluminium kathode is roughened. In parts sheltered by screens from the discharge the glass is not attacked. In potassium vapour the aluminium kathode is not evaporated to any marked degree. Opposite the kathode both in the mercury vapour and potassium vapour bulbs a dark annular stain of the shape of the kathode is formed. This stain resists the action of strong hot hydrochloric acid, nitric acid, aqua regia and potash solution. The action of hydrochloric acid removed it apparently by dissolving the glass. The tests indicate carbon, but the quantity of the stain is too small to make certain. The stain is also formed on screens of mica, quartz and calcite. Monatomic gases appear to permit the evaporation of aluminium, as Prof. Callendar has observed its evaporation in an argon vacuum tube.—On the effect of zinc and other metals on a photographic plate, by Prof. J. J. Thomson. In the course of a discussion at the Cavendish Physical Society on Dr. Russell's paper on the photographic effect produced by certain metals, Sir George Stokes suggested that possibly light might be thrown on the question as to whether these effects were due to radiation or to the vapour of the metals, if photographs were taken with a stream of air flowing between the metal and the photographic plate. In consequence of this suggestion a series of the photographs made by zinc and amalgamated zinc (1) with nothing but air between the zinc and the photographic plate, (2) when the zinc was covered with a film of celluloid, were taken both with and without an air blast. The photographs with the air blast were found in both cases to be distorted, which is in favour of the view that the effects on the photographic plates are due to the vapour of the metals.

MANCHESTER.

Literary and Philosophical Society, November 16.—Mr. J. Cosmo Melvill, President, in the chair.—Mr. Joyce showed a small pocket form of voltmeter of the permanent magnet class. It is contained in an old-fashioned watch case, the first example having been made by Mr. Joyce in 1885. The present instrument is wound to read to three volts, a reading much required in a cell tester for users of secondary batteries. In order to make the case quite smooth outside, the terminals are formed of two spring chucks contained inside the instrument and capable of gripping any wire from No. 24 to No. 18 B.W.G. Instruments have been made reading to 120 volts total.—The President communicated a paper by Mr. Peter Cameron, entitled "Descriptions of two new species of *Mutilla* from South Africa," the specimens being exhibited at the meeting.

PARIS.

Academy of Sciences, November 22.—M. A. Chatin in the chair.—On the Leonids, by M. J. Janssen. No special increase above the ordinary number of shooting stars was observed on the night of November 13–14, either in Paris or at San Francisco. It is suggested that next year arrangements should be made to secure, if possible, the spectra of some of these bodies.—On the automatic registration of the calorific intensity of the solar radiation, by M. A. Crova. Two self-registering instruments of the pattern previously described when placed side by side yield identical curves. Owing to the delicacy of adjustment, however, this class of instrument is only suitable for an observatory, the necessity for a more portable type leading to the construction of the instrument described in the present paper. This consists essentially of a thermo-electric couple, in circuit with a self registering aperiodic galvanometer. The practical trials of this actimometer at the Meudon Observatory, and on Mount Blanc, have been quite satisfactory.—On certain questions relating to the problem of Dirichlet, by M. A. Liapounoff.—On completely orthogonal systems in any space whatever, by M. G. Ricci.—On the theory of infinite transformation groups, and the integration of partial differential equations, by M. Jules Beudon.—On a method of registering photographically thermal radiations, by M.

A. Guérhard. Five illustrations from photographs accompany this paper, by which it is shown that substances whose temperature differs but slightly from that of the atmosphere may be made to produce effects upon a sensitised plate. These results show that the phenomena described by some authors as photographs of human effluvia are simply due to the temperature of the hand. —Influence of temperature upon the rotatory power of liquids, by M. Ph. A. Guye and Mdlle. E. Aston. Primary amyl alcohol appears to offer an exception to the rules formulated in previous papers for the relation between rotatory power and temperature, inasmuch as in the neighbourhood of the boiling point the specific rotation undergoes a sudden increase. An explanation of this was sought in the observations of Ramsay and Shields, which showed that liquid amyl alcohol is composed of complex molecules, breaking up into single molecules on vaporisation. To confirm this, observations were made of the rotation of amyl alcohol in water and in benzene solutions, cryoscopic determinations showing that the alcohol was not associated in water, but polymerised in benzene. The results were exactly in accordance with the above hypothesis.—On the rotatory power of polymerised bodies, compared with their monomers, by M. Berthelot. Remarks on the preceding paper.—On chlorocyanamide, by M. Paul Lemoult. A thermochemical paper.—Contribution to the study of nitrification in soils, by M. Th. Schlœsing, jun.—Influence of oxygen and other substances upon the formation of chlorophyll, by M. W. Palladine. By placing etiolated leaves containing practically no carbohydrates on the surface of certain solutions and exposing to light, it was found that saccharose, raffinose, glucose, fructose, maltose, glycerine, galactose, lactose and dextrine distinctly favour the production of chlorophyll; inuline and tyrosine are without sensible action; whilst other substances, such as mannite, dulcite, urea, alcohol, retard or even prevent completely the formation of the colouring matter. —On certain improvements to the Bourdon anemometer, by M. R. Mailhat.—An apparatus to determine in a precise manner, by means of the X-Rays, the position of projectiles in the cranium, by MM. Remy and Contremoulins. The skull is photographed successively by two Crookes' tubes placed in different positions, and the trace thus obtained projected on to the head by cranial compasses.—Remarks by M. Marey on this apparatus. In eleven preliminary experiments on the dead subject, the exact position of bullets, and even of splinters of bone, was determined with perfect accuracy. Two cases on the living subject were also carried out with complete success.

DIARY OF SOCIETIES.

THURSDAY, December 2.

Linnean Society, at 8.—On the Anatomy of *Caudina coriacea*: Prof Arthur Dendy.—On some Desmids from the United States: W. West and G. S. West.——Exhibitions: Specimens of Galls of *Cecidomya*: Prof. J. B. Farmer.—An Egg of *Echidna*: Martin Woodward.
Chemical Society, at 8.—Ballot for the Election of Fellows.—On Collie's Space-Formula for Benzene: Dr. F. E. Matthews.
Camera Club, at 8.15.—Photomicrography: Dr. Spitta.

FRIDAY, December 3.

Institution of Civil Engineers, at 8.—Permanent Way: its Construction and Relaying: Grote Stirling.
Geologists' Association, at 8.—Notes on the Geology of the Stort Valley (Herts and Essex) with Special Reference to the Plateau Gravels: Rev. Dr. A. Irving.

MONDAY, December 6.

Society of Arts, at 8.—Gutta-Percha: Dr. Eugene F. A. Obach.
Imperial Institute, at 8.30.—The Mineral Resources of British Columbia and the Yukon: A. J. McMillan.
Society of Chemical Industry, at 8.—The Sulman-Teed Process of Gold Extraction: H. L. Sulman and Dr. F. L. Teed.
Victoria Institute, at 4.30.—Paper by Rev. H. Lansdell.

TUESDAY, December 7.

Anthropological Institute, at 8.30.
Röntgen Society, at 8.30—Adjustable X-Ray-Tubes: A. A. Campbell Swinton.
Royal Victoria Hall, at 8.30.—Klondike: Dr. T. K. Rose.
Institution of Civil Engineers, at 8.—Paper to be further discussed: On the Law of Condensation of Steam: Hugh L. Callendar, F.R.S., and John T. Nicolson.

WEDNESDAY, December 8.

Society of Arts, at 8.—The Mining and Metallurgical Industries of Sweden as shown at the Stockholm Exhibition of 1897: Bennett H. Brough.

THURSDAY, December 9.

Royal Society, at 4.30.—The following Papers will *probably* be read:—On the Densities of Carbonic Oxide, Carbonic Anhydride, and Nitrous Oxide: Lord Rayleigh, F.R.S.—On the Application of Harmonic Analysis to the Dynamical Theory of the Tides. Part II. On the General Integration of Laplace's Dynamical Equations: S. S. Hough.—A Note on some Further Determinations of the Dielectric Constants of Organic Bodies and Electrolytes at Very Low Temperatures: Prof. Dewar, F.R.S., and Prof. Fleming, F.R.S.—On Methods of making Magnets independent of Changes of Temperature, and some Experiments upon Negative Temperature Co-efficients in Magnets: J. R. Ashworth.—The Electric Conductivity of Nitric Acid: V. H. Veley, F.R.S., and J. J. Manley.—On the Calculation of the Co-efficient of Mutual Induction of a Circle and a Coaxial Helix, and of the Electromagnetic Force between a Helix and a Coaxial Circular Cylindrical Sheet: Prof. J. V. Jones. F.R.S.—On the Refractivities of Air, Nitrogen, Argon, Hydrogen, and Helium: Prof. W. Ramsay, F.R.S., and M. W. Travers.
Mathematical Society, at 8.—The Construction of the Straight Line joining Two Given Points: Prof. W. Burnside, F.R.S.—A Theorem concerning the Special Systems of Point Groups on a Particular Type of Base Curve: Miss F. Hardcastle.—A General Type of Vortex Motion; R. Hargreaves.
Institution of Electrical Engineers, at 8.—Annual General Meeting.

FRIDAY, December 10.

Royal Astronomical Society, at 8.
Malacological Society, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Manuel d'Analyse Chimique: Dr. E. Fleurent (Paris, Carré).—Psychologie als Erfahrungswissenschaft: H. Cornelius (Leipzig, Teubner).—Handbuch der Photographie: Prof. H. W. Vogel. iii. Theil. Die Photographische Praxis, Abtg. 1 (Berlin, Schmidt).—The Dawn of Civilization: Egypt and Chaldæa: G. Maspero, translated by M. L. McClure, 3rd edition (S.P.C.K.).—A Handbook to the Geology of Cambridgeshire: F. R. C. Reed (Cambridge University Press).—Petrology for Students: A. Harker, 2nd edition (Cambridge University Press).—The Journals of Walter White, Assistant Secretary of the Royal Society (Chapman).—Modern Architecture: H. H. Statham (Chapman).—Annuario de Estado do Rio Grande do Sul, 1898: G. A. de Azambuja (Porto Alegre).

Pamphlets.—Aims and Methods of Education: Prof. P. Smith: Birmingham, Cornish).—Rousdon Observatory, Devon, Meteorological Observations, 1896 (Rousdon).—Some North American Coniferæ: E. S. Bastin and H. Trimble (Philadelphia).

Serials.—Rousdon Observatory, Variable Star Notes, No. 2 (Rousdon)—Proceedings, and Transactions of the Queensland Branch of the Royal Geographical Society of Australasia, Session 1896–97 (Brisbane).—English Illustrated Magazine, Christmas (198 Strand).—Longman's Magazine, December (Longmans).—Memoirs of the Peabody Museum, Harvard University. Vol. 1, Nos. 1–3 (Cambridge, Mass.).—Natural Science, December (Dent).—Humanitarian, December (Hutchinson).—Zeitschrift für Wissenschaftliche Zoologie, lxiii. Band, 2 Heft (Leipzig, Engelmann).—Good Words. December and Christmas (Isbister).—Sunday Magazine, December and Christmas (Isbister).—National Geographic Magazine, November (Washington).—Terrestrial Magnetism, September (Cincinnati).

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THURSDAY, DECEMBER 9, 1897.

SOME UNRECOGNISED LAWS OF NATURE.

Some Unrecognised Laws of Nature. An Inquiry into the Causes of Physical Phenomena, with Special Reference to Gravitation. By Ignatius Singer and Lewis H. Berens. With illustrations. Pp. xvi + 483. (London: John Murray, 1897.)

"AT last, after years of patient plodding in dim regions, where the footprints are few and the pitfalls many, the time has arrived when we are enabled to place before the world of science the first-fruits of our explorations."

So say the authors, Messrs. Ignatius Singer and Lewis H. Berens, at the opening of the preface to a handsome volume of nearly 500 octavo pages, published under the above title by Mr. John Murray, and printed in good style by the printer to the University of Oxford.[1] A subordinate title tells us that it is "an inquiry into the causes of physical phenomena, with special reference to gravitation," and a cursory inspection shows that it is decorated with quotations from great writers and philosophers at the head of each chapter, and that it is altogether a most ambitious work, courting the widest and closest attention.

The present reviewer is not one to regard lightly the danger of summarily rejecting a germ of new discovery because it happens to conflict with orthodox opinions, nor has he failed to have borne in upon him the conviction that there are indeed many real laws of nature at present unrecognised, some unsuspected, others scouted, by contemporary science.

It is, therefore, in no spirit of levity that he finds it his duty to state not only that the present volume contains much that is plainly and simply trash, he has to state further that, so far as he has been able to judge, there is nothing in it of the slightest value from cover to cover.

The former of these statements it is easy to justify by quotation; the latter may very likely be considered by the authors as an unfounded individual opinion typical of the arrogance of every professed physicist with regard to any novel view of the universe which may be brought to his notice. It is, however, difficult to imagine what manner of men these authors can be, nor how it happens that writers so conspicuously ignorant of the elements of physics, beyond what they have culled from a superficial acquaintance with a few popular books, should yet think fit to overflow in a wordy and pretentious volume, controverting many of the best-established scientific truths, criticising lightly the acknowledged masters of science, and setting forth a quantity of false philosophy and misapprehended facts with a flourish as if a new Principia were being given to the world. Who, again, are the readers of such a book? It has been most respectfully received in some quarters. Can it be that the state of school education in England is such that any considerable number of men of letters or of philosophy, or any other branch of study, find themselves able to accept such a book as this as containing possibly as good and sound science as, let us say, Thomson and Tait? Neither work is by them really read; perhaps both works seem to them nearly on a par. Perhaps they think that since Thomson and Tait and Helmholtz and Newton are all adversely criticised in the work before us, it is very likely true that the pretended facts of our boasted science are all uncertain fictions, and that the authorised scientific version of to-day is little better than a mass of hypothetical dogma.

If any such suspicion is in the slightest degree possible among the members of so-called educated society, it means that we are, after all, not far away from the dark ages; the death of a comparatively few individuals would perhaps loosen the grip of the human race on the truths of science, and plunge us once more into pre-Galilean ignorance. It is to be wondered if there are not more than a few who would welcome the change.

If the book is really an isolated phenomenon, it is as insignificant as the customary production of those paradoxers who were so delightfully gibbeted years ago by De Morgan; but it has not the usual air of the work of the paradoxer: the first half, at any rate, may easily impose upon the unwary as being a serious and sober attempt to solve perplexing problems, and contribute to the progress of natural knowledge. Sober and serious in intention we doubt not that it is, we do not suppose that the authors are playing off a conscious and expensive hoax; but, without the slightest desire to be abusive, we must maintain our view that a very small ingredient of common modesty would have prevented their shouting out their ignorance to the world—would have withheld them, with their little pittance of popular knowledge, from "undertaking to write the whole body of physicks," as Montaigne has it.

However, it is only fair now that we give some idea of the scope of the book, and that we make from it some illustrative extracts, so as to justify the terms of strictly measured depreciation which we have been constrained to use in our attempt to estimate it truly.

The four great fundamental and universal laws of nature, according to Mr. Singer (we are told in a note at the end of the preface that the science and philosophy of the work are exclusively due to Mr. Singer), are Persistence, Resistance, Reciprocity, and Equalisation.

The law of persistence is thus worded: "All matter tends to persevere in whatever state it may happen to be, and to resist change"; merely a simple and vague parody of part of the first law of motion, but it is intended to be much more comprehensive, and to include among other things such a statement as the following: "All organisms have a tendency to preserve their structure, organs, functions, habits, and dispositions unchanged."

As to "Resistance," we are told that it is the same thing as Persistence, and constitutes its quantitative measure; so the law of resistance, if it were to be stated definitely, would become a part of Newton's second law. The authors, however, rather avoid definite statements, and prefer nouns in capitals or italics, as if such nouns were laws of nature. By "Reciprocity" seems to be meant

[1] We do not hereby intend to imply that the University of Oxford is responsible for, or cognisant of, the production; but we do think that some care should be taken not to let its imprimatur be even apparently affixed to such a book as the one before us.

something akin to the third law of motion, though that is not in the least understood by them; and by "Equalisation" is intended something like the second law of thermodynamics, viz. that unless a difference of state exists between two bodies, there is no activity or tendency to activity.

Thus it may be admitted that the customary teachings of science have not been wholly thrown away upon Messrs. Singer and Berens; they have acquired some rudimentary notions from their perusal of popular expositions of science, but the amount of vagueness and inaccuracy with which they have contrived to shroud those notions is almost incredible except to those who take the trouble to read their book.

In the first place, they are careful to confuse their terminology, as the following explanatory notes testify:—

"We use the terms force and energy synonymously, and in the sense of power or strength, and shall use either of these indiscriminately as the one or the other may happen to be most convenient (p. 49).

"To us 'heat' means simply temperature." Work can be got from a body by either heating or cooling it, and it is the degree of difference of temperature that is important in connection with the mechanical equivalent of heat, not heat *per se* (pp. 86, 88).

"Pressure is 'work,' and so is motion" (p. 106).

"'Force' and 'mass' (or 'weight' and 'mass') are synonymous terms; two different names for one and the same thing." And yet the proportionality of weight and mass or of gravitation force and mass is put forth as a real fact of the Newtonian theory (p. 349).

In the second place, they ignore in detail the laws which they admit in general. For instance, on p. 77 occurs the following illustration:—

"Two bodies attracting each other, the one with a force of 100 and the other with a force of 10, the stronger body would be pulled one-tenth and the lesser nine-tenths out of their respective positions."

And many other instances might be given of their entire misapprehension of Newton's third law.

There are many singular instances of what appears to be malevolent criticism, statements of the beliefs or usages of orthodox science which are utterly destitute of basis in fact. The following may serve as illustrations:—

"Confining our attention to what are called the physical sciences, we still find the greatest possible differences in both language and conception. We have hydraulics and hydrostatics, mechanics, dynamics and pneumatics, electricity and magnetism, light, sound, and heat, and so forth; each separate branch of knowledge having its own distinctive theory and peculiar terminology not applicable to the others. It is like the confusion at the Tower of Babel. The workers in the different fields of knowledge cannot understand each other, therefore cannot commune with each other for the purpose of seeing whether the conclusions deduced from one group of facts agree with the conclusions derived in other fields of inquiry."

"The close relation of the different phenomena embraced under electricity, magnetism, and galvanism is now well known, yet are they still treated as separate and distinct sciences."

On p. 39 it is asserted that Newton's pendulum experiments, whereby he proved that inertia and weight were proportional, were proofs of nothing whatever, being only equivalent to using first one balance and then another. And on p. 40 it is said that when Newton found that pendulum bobs composed of two different materials swung together if their centres of oscillation agreed, he must have adjusted their centres of oscillation experimentally by means of equal times of swing.

In other words, he was either a fool or a knave; the full-blown paradoxer would not have shrunk from the appropriate epithets. But our authors are more polite; they are good enough to say, "Our quarrel is not with Sir Isaac Newton, but with human frailty"!

"The fixing of the absolute zero at -273° C. is based on the theory that at that temperature a body would practically be annihilated—a conclusion which in a previous chapter we have shown to be unwarranted by the facts"!

There is more about this absolute zero of temperature, which is evidently a bugbear, and is considered as nonsensical as absolute position or absolute truth; in fact, on the subject of thermodynamics generally the authors are naturally afflicted with wholesale ignorance, which they believe to be scepticism. "The action of the steam engine is generally attributed to heat," they say on p. 84, "and calculations are based as to the quantity of work to be got out of a heat engine on the supposed mechanical equivalent of heat," and they proceed to point out the errors in this view. It appears that "the true cause of the motion of the piston is a disturbed equilibrium, and consequent tendency to equalisation." "Heat is no more an entity than acidity or hardness or depth of colour." In fact the whole doctrine of energy is absurd.

"The whole doctrine of 'energy,' with all its astounding and contradictory corrollaries, has not been deduced from any facts at all, but is begotten of those conceptions which have come down to us in unbroken succession from our primitive and ignorant ancestors. The facts have merely been distorted in order to make them fit into the mould of the prejudiced human mind."

After this they proceed to "deal with the error which has given rise to the doctrine of the dissipation of energy." "When estimating the efficiency or power of doing work of a body we do not measure the *force which is just necessary to arrest its motion* [as we ought to do, is implied], but that which actually causes it to move a certain distance; in which case there is bound to be a discrepancy, an apparent loss."

Joule's experiments involved also a fundamental error, "owing to his assumption that a certain weight descending a certain height in a certain time is the measure of its mechanical power."

"Where he committed the error was that he assumed the whole power of the descending weight to have been expended in driving his mechanism, [but] to produce motion in the mechanism the weight had to be greater than the resistance of the latter, . . . The power of the weight was greater than the mechanical effect in his paddles, and hence *greater than the corresponding thermal effect*. But *by how much greater* Joule never thought of determining."

No, alas, he believed practically as well as theoretically that action and reaction were equal.

"Instead of estimating the 'heat' produced by friction, and then dividing the assumed mechanical power by the number of heat units—as Joule did—he might have estimated the mechanical effect produced by 'heat,' and

then have calculated the heat equivalent of work by dividing the calculated thermal units (which no doubt he would have assumed as being all converted into mechanical effect) by the resultant work expressed in foot-pounds. Manifestly he would, in the latter case, have given too high a heat value to the mechanical effects; just as in his actual reasoning he has given too high a mechanical value to his heat units."

And then in a footnote :

"There can be no doubt that it was purely accidental that the latter process has not been adopted by Joule"!

If he had happened to make his experiments in this inverse way, the authors go on to say, the law deduced would be "that the heat energy of the universe is becoming every day more and more changed into mechanical energy."

"Thomson's error was due to his acceptance of Joule's conclusions. Joule, in his turn, arrived at his fallacious conclusions by the double error, . . . and both these philosophers have shared in the fundamental error that 'energy' is a *something* which is transferred from one body to another. Thus do we see how fertile an erroneous conception is in producing error. . . . Verily, as Lord Bacon expressed it"—

Then follows a quotation about the tendency of the human mind to reject contrary instances—not without great and pernicious prejudice—"in order that the authority of those previous conclusions may remain unshaken."

But not only do they thus misapprehend matters of real physics : the authors also fail to understand even such simple popular phrases as Tyndall's "Heat a mode of motion," and criticise it as if "mode" meant "result": saying that if heat were due to motion, then equal weights of different substances falling from equal heights should manifest the same increase of temperature (p. 165), and they go on to say that experiments on this point would be desirable. The generation of heat, they say, is due to states or acts of coercion, and in one of the few modest sentences to be found in the book they confess, on p. 163, that

"our own belief is that all bodies while in states of coercion [like compressed air] are constant sources of heating, but that the diffusion is equal to the rate of generation, and hence no sensible increase of temperature can take place."

Further on they recover from this unusual weakness, stoutly maintaining that what they call Tyndall's view of heat is quite wrong, "since heat is due to arrested motion, not to motion itself," and boldly asserting that the amount of heat generated by bodies falling from a height depends upon their hardness,

"a quantity of water or mercury falling from a certain height would not generate as much heat as would a like quantity of, say, steel falling from an equal height."

It would be tedious to follow the authors through their wild statements concerning electricity and magnetism in detail : the following brief extracts must suffice.

"The gold-leaf electroscope, consisting as it does of glass and metal, will be found to be analogous to an electric machine. Indeed, the principle of the instrument is not yet understood, and no attempt has been made to explain it" (p. 211).

"The resistance of thin wires is less than the resistance of thicker wires of the same material, which is the opposite of what is currently believed to be the case" (p. 222).

"The total resistance of 6 lbs. of copper, for instance, would be the same whether the 6 lbs. of copper were only a yard in length, with a corresponding diameter, or a mile long and correspondingly thinner."

"Air is a most powerful electric, and when between the poles of a powerful electro-magnet partakes of the character of a viscous fluid."

Then follows a reference to the usual well-known experiment of moving or spinning copper between the poles, with the following note appended :

"which shows that air is attracted by powerful magnets and held there with a firm grasp."

"The distinction between electric and magnetic attraction is arbitrary, and no more philosophic than is the distinction between light and heavy bodies, hot and cold bodies, voltaic electricity and galvanism."

The distinction usually drawn between conduction and induction is asserted to be spurious. Heat electricity and magnetism are said to be identical, being all excited by friction. Magnetic attraction may just as well be called gravitation, since the only difference is that it is not necessarily in a vertical direction.

Thus we get led back once more to the subject of gravitation, and Newton's law is replaced by the following foggy statement.

"Bodies attract each other in proportion to their different states of excitation, in proportion to relative mass, and inversely proportionally to the square of the distance and intervening resistance."

"The point of attraction of the earth for bodies on its surface cannot be in the centre . . . for that would involve the assumption that the opposite half of the globe . . . exerts a force equal to that of the nearer half."

"The theory that attraction is proportional to mass is not borne out by facts : attraction on earth is actually less where the diameter of the earth is greatest. If we turn to the heavens matters are even less satisfactory."

The astronomical determination of the mass of central bodies turns out on their view to be quite illusory.

With regard to "action at a distance," our philosophers find no difficulty whatever ; they point out that air and water and other matter only obstruct the fall of bodies, wherefore, of course the less there is between bodies the better they can attract. They quote the usual extract from Newton's letter to Dr. Bentley, and add comments

"in order to show why such luminaries of the human intellect were unable to see what to us seems as plain as the noon-day sun ; and we trust to be able to show the reader that it was again the *ignis fatuus* of suggestive words and false concepts by which these great intellects were decoyed from the path of philosophy into the quagmire of metaphysical word-quibblings."

But now, towards the end of the volume, when the Newtonian theory is once more attacked, the authors fail to keep their mantle so strictly down, and the cloven hoof of the familiar old paradoxer becomes at length conspicuous.

"This fact, that the planets do not fall into the sun notwithstanding the assertion that they mutually attract

each other, but, quite contrary to this theory, actually recede from the sun at regular intervals, is as yet an unexplained problem. In works on astronomy, however, the fact is generally glossed over, and it is made to appear as if the recessions were most satisfactorily accounted for. But on closer examination the supposed explanation turns out to be either mere rhetoric or a series of equations of abstract mathematical problems. Why, if sun and planets constantly attract each other proportionally to their quantities of matter, and inversely proportionally to the square of the distance, do they not fall into each other and all into the sun? The question is a perfectly legitimate one, seeing that every writer on astronomy has deemed it necessary to offer explanations. But these explanations are far from satisfactory, as we shall now endeavour to show."

And so they proceed ultimately to arrive at the conclusion that,

"while there is no doubt that the curvilinear motion of terrestrial bodies is due to the joint action of two forces, viz. the impelling force and the attraction of the earth, there is no evidence either direct or indirect that planetary motions are due to two such independent forces."

The ridiculous ideas capable of being formed by men of so-called education concerning the meaning and function of mathematical reasoning is illustrated on page 353, where it is said first that Newton's achievement was not what is usually supposed:

"Newton, however, has done nothing of the kind; nor has he even attempted to do so. What Newton did prove was the *proposition* that 'A body [acted on] by two forces conjoined will describe the diagonal of a parallelogram in the same time as it would describe the sides, by those two forces apart.' It is the truth of this mathematical proposition that Newton proved, and not that planetary motions are actually due to two such forces."

And then it is added:

"Abstract mathematical formulæ can never prove a fact in nature." All that mathematics can do may be illustrated by the case of a man sent to market with eighteenpence, who returns with sixpence, then on the hypothesis that he spent the difference on a dozen apples, mathematics enables us to calculate the price of each apple; or, given the price, it can find the number of apples bought.

Criticism of this sort is gravely printed. It appears to be literally true that many men, including a few schoolmasters, believe mathematics to be represented by schoolboy studies, and especially by "problems leading to simple equations with one unknown quantity."

In Section A, at Toronto, recently, Lord Kelvin implied, *en passant*, that a schoolboy in the very first month of his algebraical studies came across something which when developed led into the heart of the mathematical arcana; viz. when he came across the imaginary roots of a quadratic equation. No wonder that in Lord Kelvin's perspective quadratic equations are relegated in imagination to something like the first month of a boy's mathematical study; but, alas, many of us know boys of sixteen who have been for years at what schoolmasters call mathematics, and who have hardly yet arrived at quadratic equations. In the perspective of many a British school, trigonometry forms a sort of goal, and the elements of the differential calculus loom dim and gigantic in the far future. When feebleness of the kind quoted by the authors is believed to represent anything like mathematics, no wonder that practical men and others regard it with aversion thinly veiled by contempt.

But not only is mathematical reasoning lightly regarded by our authors, they differ from most of their species in treating experiment also in a slight and unsubstantial manner, which though by no means intended for disrespect really amounts to it. A number of experiments are quoted, some of them made apparently by the authors themselves, which if they were true would constitute some of the greatest discoveries of the century; but they are obtained in the most casual manner, as if, like the scientific hero of many novels, the authors had only to retire into a back room for about twenty minutes, in order to make the most momentous and fame-bringing discovery. We quote two instances.

"By heating a body it is made to weigh less: that is, not merely is its specific gravity lowered, but its absolute weight is less, and it regains its former weight on cooling" (p. 380).

"Our explanation of this is that, though cool to touch, the molecules are still in a state of excitation, and hence their lesser weight" (p. 383).

"Another experiment was made as follows. A glass tube sealed at one end was contracted in the middle. In the lower portion were placed about 10 c.c. of water, and in the upper portion a stick of dry potassium hydrate of about an equal weight, and the tube was sealed. After cooling, the tube was weighed and then turned upside down, so that the water could flow on to the potassium hydrate. The stick of potassium hydrate partially dissolved, and the solution crystallised. On weighing it was found to be lighter by about 20 mgr. On shaking the glass the crystals partially redissolved, and the tube became heavier; but after some time the crystals re-formed, and the tube weighed again less" (p. 384).

On pp. 397 and 401 we are told that inside the crust of the earth there is a neutral sphere or zone outside which bodies press inwards, but within which they press outwards, so that gravity at a certain depth in the earth is inverted and bodies press upward. So this naturally explains volcanoes,—in fact the earth, if cooled, might explode like a Rupert's drop (p. 402).

Matter from the interior, if it ever got above the neutral zone, would be found to be light instead of heavy, and hence it is that the dust of Krakatoa took so long to settle (pp. 400 and 407)!

After this we can be surprised at nothing, and so we go on to learn:—

That the axial revolution of the earth is due to the radiation of the sun, like the motion of a radiometer or of a sunflower.

That the real diameter of the earth's orb is 506,734, and not 8000, miles.

That by reason of its axial rotation the earth rolls on its own orb, pressing against the zone of neutral attraction, and thus effecting its annual journey round the sun like a coach-wheel.

That the sunspots are circumsolar planets with satellites, their apparently irregular shape being an easily explained optical illusion.

That the terrestrial seasons are caused by unequal solar attractions; and other extraordinary nonsense.

We will on these topics make only two quotations, though the exposition of the doctrines occupies several chapters.

"Nobody will question that at a certain distance between sun and earth a body will be more strongly attracted by the latter than by the former, or by the former than by the latter, as the body may happen to be nearer the one or the other. In other words, nobody will question that the earth has its own field of attraction as against the sun; hence all that is within that field of attraction would form part and parcel of the mass. Now, the distance between earth and sun is at all times determined by their relative states of excitation, as before explained. Hence the earth may be regarded at any one moment as being kept at a certain definite distance from the sun, as if held there by ropes or bars. But the earth revolves, and in revolving meets with a greater resistance on the side nearest the sun than on the opposite side; hence there is greater retardation on the one side than on the other: from which follows the translation in orbit. The laws of rigid mechanics find, therefore, here application. The earth is drawn towards the sun, but cannot pass a certain line; *and this line is the rigid surface against which it presses.* To the eye nothing may be there impenetrable; but to the earth this invisible circle is like a hoop of adamant, against which it presses and along which it is rolling in space."

And this brief note:—

"Prof. Helmholtz estimated the depth of the luminous envelope at 500 (!) miles. This estimate . . . is ludicrous."

Thus at length the lofty position appropriate to superior knowledge is fully assumed; and from pitying and apologising for Newton, rebuking and correcting Thomson and Tait for their fundamental errors, the authors proceed to laugh at an estimate by von Helmholtz.

Behold, a greater than these men has arisen; another still larger volume already in manuscript is threatened; and the natural philosopher of the twentieth century is to be Ignatius Singer! O. J. L.

PHILOSOPHY OF KNOWLEDGE.

Philosophy of Knowledge. By Prof. G. T. Ladd. Pp. xv + 614. (London: Longmans and Co., 1897.)

PROF. LADD, of Yale, is well known as an industrious writer on psychology, and upon philosophy regarded mainly from a psychologist's point of view. The present volume gives his Theory of Knowledge, and with some *naïveté* he claims for it "the treatment due to a pioneer work," and avows a "quite unusual interest" in its success. His method he characterises as a constant striving "to make epistemology vital—a thing of moment, because indissolubly and most intimately connected with the ethical and religious life of the age."

Most modern psychologists of note have definitely broken with that abstract and detached view of their science which would argue the question of the "origin" of knowledge within the limits of a narrow subjectivism, and which would assume that thereby the questions of nature growth and validity had received adequate solution. The present tendency of psychology is rather to offer itself as that specialist training which makes general metaphysic profitable, or, at any rate, to endeavour to set itself right with metaphysic, by an alliance based, perhaps, upon a compromise.

Of such a tendency Prof. Ladd is a representative. He puts forward a strenuous plea for an ultimate view of knowledge and reality which shall neither be subjective idealism nor crude realism, neither wholly dualism in one sense of that word, nor wholly monism in one sense of that word. He insists on the implication in the act of knowledge of what he not very happily calls "extra-mental" or "trans-subjective" reality, meaning that we apprehend that which is manifestly independent on our individual consciousness, and does not emerge in it as a a matter of course as the result of its own laws. He urges the claims of our feelings and our will to be satisfied equally as well as our thinking taken abstractly. He demands as a sort of postulate of faith that we take it that things are known in some sense as they are. The self, he holds, is known as it really is, thinking, feeling, and willing. And things are known as what will not always as we will, and by an analogical *saltus* as other will.

This is interesting speculation, but it is rather eclectic than original. Prof. Ladd would seem to be a pioneer only in the sense that we are at present fortunately free from *Erkenntnisstheorie* as it is too often understood in Germany. For he is something too well read in theories of knowledge which pass with undue freedom from psychology to metaphysic, and often approach perilously near to *ignoratio elenchi.*

It is in his criticisms that this influence, which constitutes, as we venture to think, the weakness of his work, makes itself apparent. Interlined with positive views as to the relation of faith to knowledge, of æsthetic and ethical value to reality, where Prof. Ladd obviously owes much to Lotze, or as to the relation of thought and reality to will, where Wundt's influence is manifest, there are offered an erudite though inconclusive history of opinion and a running fire of uncomplimentary comment upon Kant, Mr. Spencer, Mr. F. H. Bradley, and others. And the sympathetic insight of the successful critic is wanting to the Yale professor. The results, as well as the methods, of certain thinkers are agnostic or sceptical, and that must not be. And so a discursive appreciation of various points of their doctrine is put forth, which, *e.g.* in the case of Kant, ranges, with the exception of a suggestion as to the implication of will in the treatment of the second analogy of experience, entirely within the circle of commonplaces on the subject, and is altogether unconvincing to believers in the results of sympathetic interpretation. Again, in dealing with post-Kantian idealism, it is not its alleged panlogism which he criticises, as he might well have done from his Wundtian standpoint, but rather its general tone or points so truistic that any theory of knowledge must, and if not explicitly yet tacitly does, meet them.

The discursive and rhetorical style of the book would of itself tend to ineffectiveness in matters of criticism. It is often picturesque, and has many happy phrases; it sometimes rises to eloquence, and is always eminently readable. But it is singularly vague and elusive. And the volume needs condensation. H. W. B.

OUR BOOK SHELF.

Bau und Leben unserer Waldbäume. Von Dr. M. Büsgen, Professor an der grossherzoglich sächsischen Forstlehranstalt in Eisenach. Pp. viii + 230, mit 100 Abbildungen. (Jena: Verlag von Gustav Fischer, 1897.)

THIS comprehensive volume on forest botany, which is essentially on the same lines as the well-known text-books of Döbmer-Nobbe, Hartig, and Schwarz, gives an interesting account of the structure and physiology of forest trees. The introductory chapters are devoted to a general external survey of the tree, note being made of the various forms of buds and shoots, while the influence of their position and development on the habit of trees is clearly indicated. An interesting subject is touched upon in the annual and periodic rate of height-growth, and reference is made to the relationship that exists between the rapidity of growth in youth and the light-requirements of trees. With hardly an exception trees that are intolerant of shading grow with great rapidity when young (larch, birch, &c.), and are thus enabled to keep their crowns well above the level of those of competing species. Slow-growing species, on the other hand, are not prejudically affected by moderate shading (silver fir, beech, &c.). Were they otherwise they could hardly have survived in the mixed primæval forest, where the struggle for existence proceeded without interference from the woodman's axe.

An important section of the book deals with the annual wood-ring, the characteristics of which are so useful in aiding in the identification and in explaining the properties of timber. Although our knowledge of the causes that lead to modifications in the annual ring of trees has been much advanced of recent years, there are still many interesting problems awaiting solution, as, for instance, in the matter of eccentric growth. The explanations that are usually offered can hardly be said to be sufficient to account for the constant eccentricity that occurs on sections of wood taken from roots and branches, as well as from stems that have grown upon a hillside. And even after all that has been written by Sachs, de Vries, Krabbe, Hartig, Strassburger, and others, who will confidently say whether pressure, nutrition, physical exhaustion of the cambium, water, or heredity is the true cause of the difference that exists in the structure of wood formed early and late in the growing season?

After discussing the formation of duramen and the properties of timber—where, by the way, one misses any reference to the latest work of Roth in America and of Schwappach in Prussia—the author proceeds to an examination of the leaf and root. As was to be expected, a good deal is said regarding the many theories that have from time to time been advanced to account for the ascent of water in trees—so ably summarised up to date by Marshall Ward in his book on timber—and while greatest prominence is given to Strassburger's experiments, the work of Dixon and Joly receives appreciative recognition. A chapter on fruits, seeds, and seedlings completes a volume which, while designed chiefly for foresters, cannot fail to be of use to a larger public, and especially to students of botany.

WILLIAM SOMERVILLE.

Physiography for Advanced Students. By A. T. Simmons, B.Sc. Pp. viii + 483. (London: Macmillan and Co., Ltd., 1897.)

THIS book is a supplement to "Physiography for Beginners" by the same author, and for those who have mastered the earlier work it will furnish an excellent continuation course. Matter, energy, the air, the sea, and kindred subjects occupy more than half the volume, while the description of the different members of "the universe" and of the various natural laws relating to them, occupies the remainder.

Both terrestrial and celestial subjects are admirably dealt with, the explanations being clear and to the point, and the selection of illustrations, which number 218, leaves nothing to be desired. The experimental method so successfully adopted in the previous book has been adhered to as far as possible, though there is naturally less scope than before for this treatment. Another notable and praiseworthy feature is the large number of references to books and *Proceedings* of societies dealing with special branches of the subject, and it is much to be desired that advanced students should acquire the habit of utilising information of this kind.

At the end of each chapter is a series of test questions, which will doubtless be greatly appreciated by teachers. There is also a summary of the chief points of each chapter, which will be valuable if not misused; but there is possibly some danger of the less serious students confining their studies to these condensed statements.

We believe that the book will admirably supply the need which must have been felt by teachers and students under the new conditions created by the revised syllabus. In conjunction with the volume to which it is a supplement, it will also provide the general reader with a comprehensive view of the earth and its relation to other bodies in space.

Chemistry for Photographers. By C. F. Townsend, F.C.S. Pp. xviii + 158. (London: Dawbarn and Ward, Ltd., 1897.)

GREAT is the number of those who practise the art of photography at the present day, but how many of these are acquainted with the chemical reasons underlying the numerous manipulations which are performed? Every photographer, it does not matter how much or how little he employs his camera, should make himself familiar with, at any rate, the chief rudiments of this science, even if he does not wish to enter more deeply into details.

The book which we have before us gives the reader a concise and clear insight into the various chemical questions which come into the sphere of photography. The author has carefully drawn attention to the fact, that by good judgment, and by paying heed to the actions of various chemicals employed, the photographic plate can be made to give results far better than when such knowledge is lacking.

Not only is the chemistry of the photographic image, developers, reversal, intensification and reduction, printing, &c., clearly explained, but useful information is collected, bearing on impurities, recovery of residues, cellulose, resins, varnishes, &c. Curiously enough, no mention is made concerning the pros and cons of mounting solutions, an important question for those who wish their prints to last more than a year or two. Perhaps this subject will receive attention in a future edition.

The book should be read by all who wish to gain an insight into the chemical side of photography.

My Fourth Tour in Western Australia. By Albert F. Calvert, F.R.G.S. Pp. xxvii + 359. (London: William Heinemann, 1897.)

MR. ALBERT CALVERT has written much upon Western Australia, and has been generous in publishing his views and convictions as to the mineral resources of that Colony. He now informs his readers that the object of previous works was to advance the interests of the Colony, whereas in the present volume the subject is treated "entirely from a personal standpoint." Open confession is proverbially good for the soul, and by declaring that the book contains a narrative of personal impressions, intended to interest and amuse the public, Mr. Calvert leaves no room for doubt as to the purpose of his new publication. In keeping with this object, a number of illustrations of purely personal matters are included in the volume.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Astronomical Constants and the Paris Conference.

MANY objections have recently been raised—above all, in America—to the decisions of the International Conference that met in May 1896, at Paris, with the object of choosing a uniform system of fundamental stars and astronomical constants for the four great ephemerides of Berlin, London, Paris and Washington. The matter is of the greatest importance, inasmuch as it refers to the bases of precise astronomy, together with a general tendency of all science to a method of international discussion that, leaving free and autonomous all personal and local initiatives, bring workers in such agreement as is necessary for nullifying discrepancies and contradictions. Of such tendency we have the most comforting manifestations in the International Geodetical Association, in the Commission (also international) for unifying weights and measures, and in the similar meetings of scientific men of every nation for the electrical measurements, for meteorological services, for the photography of the heavens. Astronomy is, perhaps, among all physical sciences the one destined by its historical tradition, no less than by its present and future necessities, to second—nay, to promote and develop—the cosmopolitan tendency. The grand spectacle of the face of the heavens, ever before the eyes of all; the difference of phenomena according to the horizons, which carries with it the need of co-operation between the observers diversely situated with regard to the celestial sphere; in fine, the high and significant moral education that comes to astronomers from the continual contrast between the immensity of the heavens and the miserable narrowness of the limits traced out conventionally on the globe between one country and another; here are the causes through which a spirit superior to any narrow nationalism was soon breathed into our souls. Tycho Brahe, the proud Danish patrician, the founder of practical astronomy in the Renaissance, sings sternly—

Omne solum forti patria est, coelumque
Undique supra. . . .

And his name, with those of Copernicus, Kepler, Galileo and Newton, form a constellation that shines not more for the sky of Denmark, than for that of Germany, Italy, or England!

On the other hand, on the sentimental considerations of the solidarity of the human race, to which a great weight must always be given, other arguments of a more modest and more positive character rest and flourish; these comfort, and, if I do not deceive myself, put out of all reasonable doubt the necessity of imprinting on our science an international character. From the day in which Frederic William Bessel solidly constructed, on the admirable observations of James Bradley, the "Foundations of Astronomy," enriching with his teutonic analysis the product of the patient British ingeniousness, a new current of collaboration among astronomers of every country was opened. The works of the said Bessel, of Struve, of Argelander, and lately those of Auwers and Newcomb, set out by admitting that the modern era of precise astronomy opens with Bradley, as the era of the Renaissance began with Tycho Brahe, and the Hellenic with Hipparchus. Each of those three great observers had his precursors, whose work seems to establish a mysterious continuity with the astronomy of the civilisation immediately preceding it. Aristillus and Tymocharis, the first Alexandrian observers, are connected with the astronomy of the Oriental nations; King Alfonso of Castile, Paolo Toscanelli and Regiomontanus with that of the Arabians; Hevelius, Cassini, Flamsteed with that of the Renaissance. But as in the great catalogue of Hipparchus we have the measure of what the genius of the Greeks could give when applied to observations of the heavens, as only in the celestial places determined by Tycho Brahe we have the material for the new planetary theories of Kepler, which led to the discoveries of Newton, so to Bradley (and to Bradley alone) we must refer the rational application of these delicate means of astronomical observation that, revealing the most minute corrections to be applied to the places of stars, led to the foundation of a sidereal astronomy. The precession of the equinoxes more rigorously determined, the nutation of the terrestrial axis and the aberration of the fixed stars discovered and measured in their effects; the places of 3222 stars exactly settled in regard to the fundamental circles of the sphere, with a precision unknown till now, and comparable only to that of the modern meridian observations: these are the fruits of the long, fatiguing and sapient vigils of the Royal Astronomer in that Greenwich Observatory whence astronomy issued transformed one hundred and fifty years ago.

But if Bradley merited in the competent and severe judgment of Bessel the glorious epithet of *vir incomparabilis*, if Lindenau and Struve had been able to say that astronomy had been renovated at Greenwich and that the work of the great English observatory surpassed at the end of the eighteenth century all remaining astronomical productions, if, after the exhaustive discussion of Bessel (*Fundamenta Astronomiæ*), Bradley's work has still been good enough for a more refined elaboration in the last quarter of our century, by the merit of Auwers, who has given it all the value of which it was intrinsically susceptible, it is no longer allowable nowadays to put entirely on one side all the material that has been accumulated from 1750 till now, and which ought to concur with Bradley's observations in fixing with all possible approximation the values of the fundamental constants and the coordinates of the leading stars. As to what refers more especially to the precession of the equinoxes and to the proper motions of the stars, it is undeniable that the value of Bradley's observations is notably augmented by their antiquity: the greater the length of time that has elapsed, the more is manifested the influence of corrective terms, in which time itself is multiplied by the coefficient of the precession or by the proper motion on the one or the other coordinate. But to render such influence really efficacious in the calculation of the factors that enter into the same terms, it is necessary that the lapse of time should be so great as to carry the terms that contain it to a higher order of term (unknown) that represents the accidental and systematic errors of the places settled by Bradley. Now no one could affirm that the century and a half that has passed between Bradley and our time be sufficient for this; on the contrary, indications are not wanting that authorise an opposite opinion. Shall we, for this, resign ourselves to a perfectly passive indifference, allowing time to mature the terms still too restricted? For the accidental errors, there is nothing else to be done; but they are not the most dangerous, and, on the other hand, the abundance of Bradleyan observations would allow us in many cases to rely upon fortuitous compensations. For the systematic errors, however, the case is different. We can and we ought, with all the means of investigation with which the improved state of the science furnishes us, to seek out those systematic errors that still remain in Bradley's Catalogue, even after the acute revision of Auwers. Such a work would in no wise be irreverent to the labours of the talented Berlin astronomer, who, for the first, has given us precious materials for investigations of that sort, by his new and masterly discussion of the observations that Tobias Mayer made at Göttingen, contemporaneously with those of Bradley. It is necessary in a special manner to ascertain (as my revered master Schiaparelli suggests to me) whether and how far it is possible to render independent of Bradley the enormous amount of observations made by Piazzi at Palermo between 1792 and 1814. To such research I am now attending, while at the New York Observatory (through Dr. Davis) and at Turin the elements are being prepared in accord for a new reduction of the Palermitan Catalogue. Until such a reduction be completed, and until analogous researches have been instituted on all the observations that can lend themselves to the solution of the problem, and that were executed in the first half of the century, it will be vain to impose by international agreement the values for the precession and for proper motions that should be not provisory. The antiquity of the equinoxes observed by Bradley is not sufficient title to make us exclude *à priori* equinoxes more recent but more precise, those observed in Germany especially. For the needs of astronomy until now Bradley's work has rendered incalculable service; but what Bradley could by himself give, he has given. It is perhaps illusory to believe that a deeper and minuter discussion (as is undoubtedly Newcomb's last, compared to those of the Struves) can lead us to a more intimate knowledge of the truth.

But it is not alone in the exclusion of intermediary observations, of those in a special manner belonging to the first half of our century, that the conclusions of the Paris Conference find serious objections, for what refers to the precession and to proper motions. As Prof. Lewis Boss notes in a deep and animated

paper in the *Astronomical Journal*, two great astronomical undertakings adapted to throw new light on the controversy await their fulfilment: the zones of the *Astronomische Gesellschaft* and the Catalogue of the Paris Observatory. Notwithstanding the differential character of the first, and the heterogeneous origin of the second, Prof. Boss thinks that we cannot estimate from these two copious springs of information on the proper motions, in which the abundance of data compensates (in certain limits at least) their dependence upon the errors of the fundamental systems adopted.

Allow me to add another consideration to those put forward in all competence by the American astronomer. The problem of the precession is indivisible, as we have said, from the problem of the proper motions: the problem of proper motions may depend in its turn on the displacement of the solar system in space. Now there is no doubt that a solution, fit to be considered definitive for a long series of years, is still wanting as to the last problem. And the reason of it is clear: it has been till now attacked on different sides, but always with individual method, inherent (we must say) to the state of science, that has not yet mobilised all its forces for a simultaneous attack. The classical methods based on confronting between stellar coordinates observed at many years' distance, and on subtracting in the observed displacements the parallactic part from that due to the real motion of single stars, are singularly convenient to determine the directions of the translatory movement of the solar system. To determine its velocity it is instead more convenient to use spectroscopic methods, with which the velocity of each star is measured in the direction of the visual ray. The very brief time that has elapsed since the day that Vogel, at Potsdam, with such ability rendered possible the measurement on the photographs of the slender and nearly imperceptible displacements of the spectrum lines, has not yet allowed this method to be applied in all its potentiality, the fecundity of which Secchi had already divined, as many worthy observers, such as Pickering and Maunder, had attempted to practically employ it. When the new photographic equatorial (to be mounted at Potsdam) has given the means of studying a large number of stars inferior to the second magnitude (which is the limit till now of the instrument used by Vogel), when the rigorous proceedings of the illustrious German spectroscopist become familiar to the American astronomers, who until now are perhaps the only persons to whom the question of expense presents no difficulty, when a new installation is to be made, then, and only then, the moment for approaching the solution of the problem of the solar translation in space by the medium of a rational combination of astronomical and spectroscopical methods will be arrived.

Once the movement of our system is known with sufficient exactitude, it will be easy to eliminate its effect from the proper motions of the stars, which can then be reduced, free from all systematic part, to the merely accidental variations of the coordinates, and can therefore be treated as accidental errors, and submitted to calculation, together with the eventual correction of the constant of precession. This will only gain in precision the longer its deduction is delayed, which, for obvious reasons, may be afterwards made definitive for a long series of years. It is exactly for such a consideration that I think it right that all the equinoxes determined after Bradley's, and which are not affected (as those of Piazzi are) by incurable errors, should be used in the new determination of precession, it being possible only, from the comparison of these equinoxes, to rise again by extrapolation to Bradley's epoch, with data adapted to render clear the law of the systematic errors remaining in the revision of Auwers.

As to the nutation, it does not seem that the value 9"·21 of this constant, adopted by the Conference, has yet given rise—at all events, in public—to disputes and oppositions. Anyhow, it will not be useless to remember that fresh rigorous determinations of it were by several authorities demonstrated to be necessary in recent years, and that especially the persistent uncertainties have their being through the disagreement, not yet well explained, existing between the value of the terrestrial flattening given by the mechanical theory of the nutation and that given by geodetical measures. Harkness has sustained the need of a new series of observations, tending to furnish a new value of the constant of nutation, more precise than that of Peters. While such a series is projected and executed (and it will be necessary to prolong it at least for one of the periods of nineteen years that reconduct the node of the moon's orbit to the equinox), the discussion of the enormous geodetical material that is being accomplished will furnish us more secure facts as to the flattening and to the moments of inertia of the earth, thanks to the comparison between the values given by the arcs of meridian and by the measured lengths of the pendulum for seconds. Hence a correction (that can be but arbitrary) seems premature as to the value already assigned by Peters, whose exactitude, according to Harkness, is remarkable.

For the solar parallax, the Conference thought it opportune to fix a value of 8"·80, by an act of authority unjustified by sufficient explanations. This appears to many astronomers to be an acceptable mean among the most discordant values that laborious researches have furnished in the last twenty years. The lamented Tisserand found no other motive for being satisfied with this choice, except its approach at less than a hundredth part of a second to the value fixed by Laplace. But the example of the famous mistake of Encke, not too opportunely quoted by him, should have admonished him to use greater prudence. We have, it is true, two distinct groups of results in these last years; some approximate to the value of 8"·75, the others about 8"·85. Are we to conclude that the first defect 0"·5, the others exceeding as much? Or is it not—given the great intrinsic accordance of the single determinations on which every value reposes—more legitimate to suspect that some series are affected by constant errors relatively enormous, and such to take weight from them all in the definitive discussion? The fact is that, notwithstanding the transits of Venus and the oppositions of Mars, notwithstanding the photographs and the heliometers, or the combined forces of men of value like Gill, Auwers, and many others, the problem of the parallax remains more open than ever. It is true that, as Boss remarks, one active period for this research seems at an end; but it is true also that, on the contrary, the question of the aberration is more lively than ever; and that, in the present state of astronomy, it would be absurd to settle the value of the former just when the greatest efforts are concentrated on the latter. To avoid contradictions, I see nothing better at present than to adopt (which, for the immense majority of astronomers, would simply mean to preserve) the constant of aberration given by Nyren, and the corresponding parallax, as it is calculated with the last value of the velocity of light, determined by Michelson at Breteuil. In a few years the material for a new calculation of the aberration will not be wanting; each of the series instituted lately for the study of the variations of latitude at short periods will furnish a useful element for discussion.

We see from this rapid analysis how all fundamental problems of astronomy, even being connected with each other in a single problem, by effect of the equations of condition that unite the single constants, can, for simplicity of investigation, be gathered in diverse groups, according to the more intimate dependence of some constants upon others. We see also that the gigantic general combination, attempted by Harkness a few years ago, is really premature, but has notable importance, as the first essay of the method which sooner or later must be used. Harkness' work in every way teaches us the inutility, or at least the small efficacy, of isolated researches, that are not sought to be coordinated with the analogous researches on elements of the same group. If it be too bold to establish the solar parallax on several dozen physical constants, mechanical or astronomical, bound more or less with it, it would be too timid and behindhand not to take into account with it the velocity of light, the stellar and planetary aberration, and the variation of the geographical latitudes. The nutation joins with the constants that define the figure of the globe and the law of the distribution of matter in the internal strata of it. Finally, the precession is united to the proper motions of the stars, and to the translation of the solar system in space, elements which in their turn depend on the systematic corrections of the stellar catalogues.

A general renovation, then, of fundamental astronomy must precede a new and authoritative definition of the numbers that the twentieth century must accept as the more probable values of the constants. The compilation of a fundamental catalogue, which must be the consequence of all this work, cannot be subordinated to considerations of opportunity, and much less to what Dr. Chandler shrewdly calls the "sentimental association vulgarly attaching to round figures." If, for reasons foreign to science, the editors of the *Connaissance des Temps* and of the *Nautical Almanac* will not accept the Newcomb's or the Auwers' stars, let them keep their own; the slight residuary discrepancy between the ephemeridæ will certainly be less harmful than agreement on a new provisional system, that, not having more value than the existing

ones, would acquire superior authority without justifiable motives. Dr. Auwers, who is undoubtedly the most competent person in such matters at the present time, has well delineated the limits of his fundamental catalogue, calling it not purely and simply fundamental, but "fundamental for the observations of the zones of the *Astronomische Gesellschaft*." In other words, he has not intended to do anything else than furnish an indispensable basis for the great international undertaking about the zones, and has set up a guard against extending the signification of "fundamental" that should legitimise every delicate use of his stellar positions. The researches to which he is attending now, and to which the Paris Conference justly attributes "un intérêt scientifique de premier ordre," prove how in his mind (as in those of all the astronomers assembled in Paris) the fundamental catalogue now in use may be considered alike provisional, just as the new catalogue to be compiled at the end of this century for the needs of national ephemerides. To give to-day the title and the authority of a fundamental catalogue to a collection of stars is not sufficient in fact for the single stars to answer simply to the conditions which are enumerated at page 6 (Appendix C) of the *Annuaire du Bureau des Longitudes* for 1897; it is necessary that their positions be founded on absolute observations, executed with all the precision of which perfected modern instruments are susceptible, and on an exhaustive discussion of the series obtained till now on the same stars at Greenwich, Pulkova, Leyden, Washington, and in a few other observatories. For the present time the needs of the practice will be satisfied with collections like those of Auwers, Boss, Safford, and similar astronomers.

After all, if an international accordance were proposed exclusively to cause the four great ephemerides to adopt a uniform system of constants and of fundamental stars (as it appears to have been decided at Paris), without taking care at the same time that the reasons for the preference granted to such a system should consist in the undeniable superiority of it with regard to every other pre-existing, one might say that the agreement shows the absurdity of losing time, labour and money in the compilation of four different ephemerides, whilst one alone is enough for the needs of astronomy and navigation. In fact, for what object are four separate bodies of calculators employed to draw from planetary tables the places of the sun, moon and other bodies of our system? Would not one office alone, even international, be more than enough, and one sole almanac, published in several languages? And would it not be convenient to profit by the occasion to separate more clearly than has hitherto been done what is necessary for astronomers from that which is sufficient for geodetical observers, for geographers, for sailors? The papers in the *Astronomical Journal* touch this matter with great ability, calling attention to the fact that the national ephemerides (except, perhaps, that of Berlin) show rather too much the effects of their practical destination; if this could be fused with the supreme scope of astronomy some centuries ago, when the decay of astrological tendencies obliged science, from reasons of self-preservation, to find for herself a utilitarian basis, it is not at the end of the nineteenth century that she should found on its applications the justification of her existence. Like geometry, like all positive and speculative knowledge, like fine art, even the science of the stars aims especially at the honour of the human mind, and, from this point of view, the discovery of Neptune is worth as much as the discovery of a new salutary remedy or of a new electrical engine. On the other hand, the positions of the stars and planets are now known and calculated with a precision far superior to that which suffice for the applications. An immediate accord like that of Paris seems thus superfluous for applied astronomy and premature for pure astronomy. In any way, I agree with Messrs. Boss and Chandler in the view that if an agreement is to be come to, it is not in the form in which it was given at Paris. American astronomers justly note that the bureaucratic governmental character of the four offices publishing the ephemerides is not a sufficient title for them to represent all official and private astronomical science of the different countries in the definition of a merely scientific controversy of such moment. The directors of the four ephemerides indisputably occupy an eminent position amongst their colleagues; but, whatever may be their personal merits, their opinion (in a matter that touches the foundations of science) is not such as to impress itself authoritatively and without discussion.

Moreover, I allow myself to add that such an opinion cannot bind that of the numerous astronomers that belong to countries where ephemerides are not published, and where they are compiled (as at Trieste and at San Fernando) second-hand. The resolution adopted by the organisers of the Conference of inviting Messrs. Gill and Backlund, with a deliberative vote, Messrs. Van de Sande Bakhuyzen and Trépied with a consultative vote, does not seem to me to represent anything more than a well-deserved homage rendered to those learned astronomers, and perhaps might contribute to render more significant the exclusion of other countries, such as Austria-Hungary, Italy, Sweden, Norway, Denmark, the Argentine Republic, whose astronomers till now have strongly and efficaciously contributed to the theoretical and practical study of the arguments. As to what refers specially to my own country, it may not be inopportune to recall to mind the ancient series of ephemerides published, first at Bologna, afterwards at Milan, which was interrupted twenty-five years ago in order not to lose time and money by repeating what was abundantly done at Paris, Berlin, London and Washington. The history of the Milan Observatory in this last quarter of the century, proves that the promises made by its director Schiaparelli were not vain, that thus the Observatory might "dedicate itself with greater alacrity to those researches that constitute the real progress of science" (*consacrarsicon maggiore alacrità a quelle ricerche, che costituiscono il vero progresso nelle scienze*).

Finally, I believe that the discussion on the conclusions and aims of the Paris Conference should be continued by correspondence in scientific periodicals, as well as by direct treaty between the more competent bodies. And, perhaps, it would not be without some utility were the Royal Astronomical Society and the *Astronomische Gesellschaft* to agree to examine and extend the plan devised some few years since by Dr. Gill for an international Congress of Astronomers, by which alone the deliberations of the Conference could have full and authoritative sanction. FR. PORRO.

P.S.—The present paper was already finished when I read, in No. 413 of the *Astronomical Journal*, Prof. Newcomb's reply to the criticism of Prof. Boss. Notwithstanding the reasons strenuously advanced by the learned astronomer of Washington in support of his proposal of a new value for precession, it does not seem doubtful that the question must be considered from a wider and more general point of view. No one contests the delicacy and the rigour of the procedure adopted by Newcomb in drawing out his precession: no one denies but that he has treated the difficult argument in a masterly manner, enlightening it with his original and profound views. Where it seems to me that Boss dissents from Newcomb is in the opportunity of expending such talent and labour about a material already exhausted and not susceptible of giving more sure results, in whatever way it be treated. In any way, even accepting the Newcomb's new contribution to the study of the particular question of precession with the praise due to it, the general question still remains open. —FR. P.

The Treatment of Stamp Battery Slimes from Gold Ores.

ON page 501 of your issue of September 23, there is given a brief abstract of a paper read by myself at the July meeting of the Chemical and Metallurgical Society of South Africa.

The essential features of the paper have hardly been correctly rendered in the condensation, inasmuch as at present mechanical stirrers are employed for agitation of slime-pulp, jets of air serving merely for oxidation, though their use as a means of agitation is suggested.

The primary use of aeration is described in the paper as the oxidation of FeS, FeO_2, H_2, and other reducers, so as to effect a preliminary preparation of pulp before adding cyanide; hence the KCy is not protected by the presence of FeS, which, with other ferrous compounds, has already undergone oxidation and become converted to ferric hydrate, in which state it neither consumes cyanide nor abstracts oxygen.

The CO_2 in the air blown through the pulp is neutralised by the free alkali (CaO_2H_2) present, which thus serves to protect the KCy from decomposition. W. A. CALDECOTT.

Johannesburg, November 8.

Abnormal Colours of Flowers.

WITH reference to your correspondent's communication in NATURE for December 2, on abnormal colours of flowers, I fancy the following note may be of interest. Towards the end of

August 1894, near the Bernina Hospice in Switzerland, I came across several plants of myosotis growing by a pool. In some cases the flowers were a bright blue, but in others they were distinctly pink, several being entirely pink, and others showing pink blotches and lines. The plants were in a hollow, and on the day of my visit there was an extremely cold wind blowing.

London, December 2. HECTOR COLWELL.

Fire-fly Light.

REFERRING to my reply to Prof. S. P. Thompson (NATURE, July 29), concerning fire-fly light, I can confirm what then I wrote. Mr. H. Muraoka has sent to me from Kioto in Japan a letter from which I derive the following particulars. (1) In the neighbourhood of Kioto there are about nine kinds of *Luciolæ*, which Mr. H. Muraoka continues improperly to call, in German, Johanniskäfern. (2) The insects used by him were probably *Luciola vitlicollis* and *Luciola picticollis* (Kiesenn).

Florence, December 1. CARLO DEL LUNGO.

AN ENGLISH BEAVER PARK.

SINCE the Marquis of Bute established a colony of beavers on his estate near Rothesay in 1874, no such interesting experiment has been made in acclimatising these animals as that which Sir Edmund Loder has carried out in Sussex. The beavers have now been inhabitants of his park at Leonardslee, near Horsham, for eight years, or rather they occupy an enclosure inside the park. There they have been placed on the banks of a small stream, with a rather rapid fall, a situation which exactly suits them. It is sheltered, for the valley is deep and wooded, and there was an ample supply of timber, large and small, in the enclosure when the industrious beavers, reversing the story of "Settlers in Canada," were brought from Canada and settled in Sussex. In the course of their eight years' sojourn they have ensured their comfort by constructing in great perfection, and in the most durable form, the engineering works for which beavers are so justly famed, and which gave rise to the Indian legend that the Creator, after separating land from water, employed gigantic beavers to "smooth" the earth into shape. Meantime the colony increases in number, so that some of the produce have been sold to go elsewhere. Nevertheless the beavers' industry is such that the size of their works, and consequently the area of the pool which they have formed, constantly increases.

The space in which they were originally enclosed was less than an acre. This was only one-third of the size of the Marquis of Bute's "beaver park"; but it gave quite sufficient scope for the beginnings of the colony. It was surrounded with a corrugated iron fence, which the beavers could not gnaw down, while at the same time they could not see through it, and so felt more secure and "private" in their park. Beaver engineering is directed entirely to one end. This is to form a pool deep enough and wide enough for them to be able to swim beneath the water to the entrance of their burrow, and to keep this entrance submerged in dry weather, when the streams run low, and covered with such a depth of water that even in the longest frosts, when the ice in Northern Canada is two feet thick, there shall still be water-space below it.

In the water the beaver knows it is safe; and, though it also stores branches for food below water, fastening them down with stones and mud, it is to serve as a place of refuge rather than as a storehouse, as a combined moat and temporary hiding-place, that the beaver forms his pool. All his clever engineering, his wood-cutting, building, canal-making and construction of "rolling ways," are subordinate to this end. The two last works, the beaver canal and the beaver road—the one for floating, and the other for rolling logs to the pool—are only brought into play when the supply of timber near at hand is exhausted. But they are part and parcel of beaver devices, and, though only recently brought to notice, are not less creditable than their other feats.

In the present paper we shall not use the technical phrases of hydraulic engineering, but term the reservoir made the "pool," and the containing barrier the "dam." In Canada, when the beavers were numerous, these dams were noticed to be so nicely adjusted in form to the material with which they were made, and to the force of the stream which they barred, that they could be classified in relation to these circumstances. Dams built mainly of mud and stones had a different section from dams built of sand and wood; and some made across rapid streams were curved, to resist the extra strain. But the greater number were made of battens of wood about three feet long, with the crevices stuffed with mud, stones, and the twigs and small branches; and in every case the first engineering principle necessary in the construction of a dam is observed. This is that the top shall be exactly level, so that the water of the pool, which must overflow, because the stream enters it from the top end, shall flow evenly over the whole length of the dam. As every one conversant with that most difficult form of the profession—river engineering—knows, any small gap or inequality soon ruins a dam. The water pours through these by preference, and at once cuts a gap. The beavers know this, too, and at Leonardslee, no less than in Canada, constantly examine the top of the dam, and mend the smallest gap along the line. The Leonardslee dam is of the ordinary kind, not curved but straight, and built of battens of wood, made of the boughs from trees cut down inside their enclosure, or from those which were given them as food. In all cases they ate most of the bark; then they cut the sticks into lengths of about three feet, and worked them into the structure. Plenty of mud was pushed into the crevices on the upper side, and all the small twigs and sticks were pushed in to make the whole dam tight. With great judgment they spared a small oak growing just below the dam. This now acts as a support to the structure; all the other trees in the enclosure, except those protected by metal guards, and one very large fir, were either felled, or attempted to be felled. It seems obvious that they kept this tree purposely as a buttress; for the dam is made higher and, therefore, wider each year, as the pool above increases; the tree is now almost in the centre, and its roots are already worked into the dam foundations. Even the baby beavers at Leonardslee, no bigger than rabbits, are put to "light jobs" in mending the dam, and the elders are most industrious. Each winter brings down a quantity of mud, which would make the pool shallower. But the beavers raise the dam so rapidly that the pool gains in depth, and spreads for a long distance up stream and laterally. The dam is at least five and a half feet high, and the depth of water above it five feet, yet it is so well made that, though the human-built dams of several artificial pools higher up the stream were carried away in a winter flood, the beaver-dam was undamaged. Near the point at which the stream enters the enclosure three large trees, formerly on the bank, are now submerged in three feet of water, owing to the fresh height added to the barrier below. The beavers had begun to cut these trees down—a very hard task, but one in which they would have succeeded had not the water risen so fast that they were floated off their legs when trying to go on cutting. One large beech tree, standing on a raised bank washed by the ever-increasing pool, was an object of envy to the beavers. They concluded that the quickest plan was not to cut it down, as it was very large and the wood hard, but to dig it up. So, with the aid of the increasing waters, they undermined the tree, which fell across their pool. This gave them occupation for some

weeks. They ate every morsel of bark off the trunk and branches, and then cut off the boughs, gnawed them into lengths, and took them to the dam and to their "lodge." The latter began as a burrow in the bank. As they gradually enlarged this, and filled up the bottom with wood chips, they broke open the roof to get head room, and constantly added to the dome with mud and sticks. It is now a large untidy mound on the bank, which at this point is steep.

The process described above accounts partly for the evolution of the beaver lodge from the burrow. But the keeper of Lord Bute's beavers stated that the beavers at Rothesay did clean out the old shavings which they took in to make beds of, and plastered them on the outside of their lodge, or on the same embankment. The present writer inclines to believe that this is likely to be correct, not in every case, but in some, for it is very much in keeping with beaver character. In such cases he ventures to offer the following solution of the growth of the lodge, in cases where the beavers remove their bedding of chips. The water above the dam, owing to the causes mentioned above, rises higher yearly. This must also raise the level in the sub-aqueous passage leading to the beavers' chamber, and in time tend to invade the chamber itself. To remedy this the beavers would naturally raise the floor, and leave the débris of old "beds" on it, piling fresh stuff on the top, and at the same time quarry out the roof, both for head-room and to get fresh earth for their floor. When once the artificial roof was made the same process would go on, until the rising water flooded out the floor altogether, and surrounded the lodge, as one sees it in old Canadian pictures. The lodge would thus take the beehive, moated, form which it has in those conventional plates, even though it lacks the windows which the French artists added for effect. The beavers occasionally escape by burrowing under the corrugated iron fence. This is not always intentional on their part, and they are easily caught again. Whenever one gets out it travels up the stream, visiting the pools above. There a box-trap is set next night, baited with dog-biscuit, of which the beavers are fond, and the animal is certain to be caught. One beaver, out for a stroll like this, tried to cut down a large Scotch fir, and did cut down a silver birch. The first indication to the keeper next morning that a beaver had escaped was the sight of this tree, in full leaf, lying across a path.

We mentioned above that the Leonardslee beavers had not made either a canal or a rolling path. There is no need for either; for there are no more trees to cut down, or logs to roll from a distance. But it is worth devoting a few lines to these, two of the less known, but not least extraordinary exhibitions of beaver intelligence. An old-established colony soon clears off all the timber near its home. In order to convey the more distant logs to the dam they carefully clear paths, and roll the battens of wood down to the water. But the beaver canal, to which proper attention was first drawn by Mr. Lewis Morgan, is, in the writer's opinion, more wonderful still. It is nothing more nor less than a waterway, or several waterways cut from points on the stream to such parts of the adjacent plantations or woods as the beavers wish to visit, or cut timber in. Sometimes, also, it is made through the centre of an island, to make short communication by water. To this canal the beavers roll their logs, and then tow them to their dam. It has been urged that these canals are accidental, merely worn out along the customary roads; some are, no doubt. But wherever the writer has seen tame beavers kept, even at the London Zoo, he has seen them at different times cut trenches to the edge of their pool, though as that at the Zoo was surrounded by a stone rim, the beavers could not fill the trench with water. Of course, there this trench was only a few feet long. But it is quite clear that Lord Bute's beavers, which had a considerable area in which to cut their timber, tried to dig canals. This is the description given by their keeper, who, though well acquainted with beaver stories, evidently had never heard of the canal. "Their burrows they make by cutting a road from the middle of the dam for several yards into the dry ground, where they scoop out a dome-shaped burrow. . . . Some of the roads to these burrows are from fifteen to twenty yards long, *and so level that the water follows them in the whole length*"! Here is, undoubtedly, an instance of the beaver canal.

Those who care to compare the methods of the Canadian beavers acclimatised at Leonardslee with the works and ways of the European beavers still surviving in Norway, will find an interesting account of the past and present history of the Norwegian beaver, by Mr. R. Collett ("Bieveren i Norge"),[1] illustrated with twelve plates of beaver lodges and dams, and supplemented by an English summary.

The beavers' present range is confined to the Stifts of Christiania and Christiansand, but a few remain on Bratsberg Amt and Stavanger Amt. The larger colony is on the River Nisser (or Nid), the westernmost colonies being on the river Mandal. In all cases they feed not on fir, but on deciduous trees, mainly the aspen. When not on the banks of large rivers they make dams, one of which, near Hellersli (Trungen), was built entirely in three weeks, and formed a lakelet more than 100 yards across. The length of the dam was 14 metres. In only one respect do the habits of the Norway beavers differ from those of the Canadian species. Those that live on the banks of the large rivers cannot make a dam over such rapid and deep waters. Yet these rivers rise and fall, and there is a danger of the lodge being either flooded or left high and dry. In these places the beavers build long lodges, at right angles to the stream, and sloping up the bank. When the river rises, the beaver can go up to the higher end of his lodge; when it falls, the entrance is still submerged and safe.

In 1880 Mr. Cocks estimated the number of beavers surviving in Norway at 60; in 1883 Mr. Collett believes there were 100. Since 1894 and 1895 the beavers have been protected by law in their two principal haunts, for a period of ten years in each district.

C. J. CORNISH.

SCIENTIFIC INVESTIGATIONS OF THE LOCAL GOVERNMENT BOARD.[2]

THE Annual Reports of the Medical Officer of the Local Government Board constitute in many respects the best treatise on practical hygiene we possess. Their diligent perusal by the embryo health officer would equip him as no ordinary text-book can do for the intelligent discharge of his duties. It would be well if candidates for Public Health degrees were examined upon the salient features of these reports. The volume for 1895–96, which has just been issued, contains certain features of interest. There is the usual admirable summary of the year's work by Sir Richard Thorne; statistics with regard to vaccination, and a compilation of returns of notified infectious diseases in urban districts and in the county of London. Valuable reports are also contributed by Dr. Copeman and Dr. Buchanan upon outbreaks of enteric fever, and by Dr. Sweeting upon an outbreak of diphtheria. The able report by the late Mr. R. W. Thomson upon the sewerage and drainage arrangements of certain valleys in the counties of Monmouth and Glamorgan, leads one to join in the regret expressed at the loss of this talented official. It is, how-

[1] Bergen: Grieg's "Bogtrykkeri."

[2] Twenty-fifth Annual Report of the Medical Officer of the Local Government Board, 1895-96.

ever, the auxiliary scientific investigations which call for more special notice in these columns.

The several cases of Asiatic cholera that occurred in this country during 1893, led the Local Government Board to keep a diligent watch in the subsequent year over any cases that presented symptoms of a choleraic nature, and Dr. Klein gives an account of the bacteriological examination made by him in twenty-nine instances. The comma bacillus was not found in any of the cases; they therefore proved to be examples of cholera nostras, or English cholera. This conclusion is a further confirmation, if that were needed, of the diagnostic value of Koch's methods. When Dr. Klein says, "if the vibrio of Koch could be demonstrated in the bodies of persons not connected in any way with the cholera localities of 1893, the bacteriological test as an important help in distinguishing between Asiatic cholera and cholera nostras would become practically worthless," he is surely suggesting a doubt that does not exist amongst the great mass of observers. In a number of the cases the bacillus coli. was found to be the predominant micro-organism. Of fresher interest is Dr. Klein's description of an organism isolated from cases of diarrhœal illness due to the consumption of milk, and named by him, "Bacillus enteritidis sporogenes." There is a misleading sentence on p. 196: "ordinary milk, such as is bought in many a shop in London, contains as a rule an abundance of bacillus coli, and if put aside it will rapidly 'sour' and coagulate spontaneously owing to the multiplication of bacillus coli." This might lead most readers to assume that the ordinary "souring" of milk is due to bacillus coli, and not, as is the case, to one or other of a considerable number of lactic acid producing organisms. Dr. Klein proceeds to a further report on prophylaxis in diphtheria, in which are mainly detailed the results of injecting living diphtheria cultures into the horse with the view of obtaining antimicrobic substances in the blood. The experiments do not appear to have brought out results of practical value, either with his own "antimicrobic" serum, or with antitoxic serums obtained from various sources. Dr. Klein also contributes a "Further Report upon Protective Inoculations" which will be read by all interested in the subject of which it treats.

"Snake venom in its prophylactic relations with 'poison' of the same and of other sorts," is the subject of a lengthy communication by Dr. Kanthack. The work of Calmette and others upon the effect of cobra antitoxic serum upon the poison of snakes other than the cobra is discussed, and there follow observations upon the nature of the immunity of certain snakes to certain snake poisons. Dr. Kanthack has not been able to confirm Calmette's statement, that the injection of solutions of chlorinated lime have value as a curative or immunising agent. On the other hand, as Calmette states, an antitoxic serum can be produced in rabbits by administration of the cobra poison itself, and still better results are obtained by using the mixture of venom and chlorinated calcium. The inhibitory influence of different antitoxic serums upon cobra venom is next dealt with. The experimental data given are in many respects incomplete, and it would perhaps have been well to wait till the experiments were finished before publishing any conclusions from them.

Dr. Kanthack instances the marked retarding influence of liver extracts on the action of cobra venom. This most interesting statement is supported by three experiments, and their continuation left for a future date. There follow notes on "immunising serum." It is again disappointing to find experiments quoted with the addendum, "the number of my observations are too limited." Attention should be drawn to an experiment Dr. Kanthack performed on himself with most remarkable results. In the course of nine days Dr. Kanthack swallowed 51·4 cc. of living and dead broth cultures of the cholera vibrio, and a solution of sodic carbonate to neutralise the gastric acidity. A week later blood was obtained from the arm, and 3 cc. of the separated blood serum was injected into each of three guinea-pigs intraperitoneally. Four days later the guinea-pigs were respectively inoculated with *B. prodigiosus*, *B. pyocyaneus* and *V. choleræ—only* the guinea-pig inoculated with cholera remained alive. The immunisation Dr. Kanthack had effected on himself *per os*, was apparently transmitted by means of his blood serum to the guinea-pig.

The paper concludes with notes upon Pfeiffer's, Bordet's, and Durham's tests for the cholera and typhoid organisms. It would have rendered the description clearer in one or two instances if it had been explained what actually was seen, instead of expressing the results as "not quite negative" and "did not react absolutely negatively." Dr. Kanthack considers that "a general conclusion at this stage as to the specificity of antitoxic or immunising serum would be premature," though the facts so far obtained tend to support this conclusion. The paper is one more adapted for perusal by specialists intimately acquainted with the subject than by the general reader, who might be apt to carry away false notions as to the finality of a number of the results obtained. One cannot resist the impression that the material for half a dozen researches has been crowded into the space of one paper.

The difficult subject of food poisons is considered from the bacteriological aspect by Dr. Cautley. The object of the inquiry was to ascertain whether the multiplication or pathogenic properties of bacteria normally present in the digestive tract, viz. *B. coli* and *Proteus vulgaris*, are influenced by association with the non-pathogenic organisms to be commonly met with in food. Dr. Cautley was able to demonstrate that the virulence of the above bacilli is increased by simultaneous injection with certain food organisms into animals. On the other hand, feeding experiments on similar lines gave negative results. Dr. Monckton Copeman and Dr. Blaxall contribute reports on the advantages of glycerinated vaccine lymph. The volume, like its predecessors, contains much of interest and value to sanitarians and bacteriologists.

THE ARCTIC WORK OF MR. R. E. PEARY.

ON Monday evening Mr. R. E. Peary, U.S.N., presented to the Royal Geographical Society a statement of the results of his Arctic explorations and of his plans for continuing these.

Mr. Peary has been engaged in exploring Northern Greenland for the greater part of the last ten years, and in the course of his sledge journeys he has had more opportunities of studying the inland ice than has fallen to the lot of any other explorer. The most remarkable journey of the series was that of 1892, when he crossed the ice-cap from Inglefield Gulf and discovered Independence Bay on the north-east coast of Greenland. This journey showed that the inland ice terminated to the north, and that there was no road that way to the pole. Land was seen to the northward, which Mr. Peary believes to be separated by a channel from Greenland, and to extend probably some distance beyond the furthest north attained by Lockwood on Greely's expedition, 83° 24'. A second journey to Independence Bay in 1893 was frustrated by the unexampled severity of the weather; the party, which started with forty-two dogs returned with only one. In 1895 another attempt was more successful, but the resources of the expedition and the transport available were insufficient to allow any advance beyond the position of 1892.

After this journey Mr. Peary resolved to wait until the

results of the Nansen and the Jackson-Harmsworth expeditions were available as a guide to further work, but he had no intention of abandoning his endeavour to attain a high latitude on the American side. This summer he visited Cape York in a whaler, and succeeded in taking on board and transporting safely to New York a vast mass of nickel-iron weighing about 100 tons. This block is reputed by the Eskimo to have fallen from heaven, and it bears all the external appearance of a meteorite, while it shows the characteristic Widmannstätten figures when the surface of the polished metal is etched with nitric acid. The transport of the block was a brilliant engineering feat, as the only means available for getting it brought on board and lowered into the hold were hydraulic jacks and timber stagings. We understand that the great meteorite is still the property of Mr. Peary, and has not yet been acquired by any museum. It is not to be confounded with the masses of telluric iron described by Baron Nordenskiöld.

Mr. Peary's description of the inland ice was extremely graphic, and illustrated by a superb series of coloured slides, prepared from photographs selected from his collection of over 4000. The movement of the surface he believes to be due as much to the drift of snow by the wind as to the discharge of glaciers, summer melting and evaporation taken together. The snow-dunes in parts convert the inland ice into a veritable Arctic Sahara. In addition to collections of the restricted but brilliant flora of the ribbon of land freed from snow in summer along the coast of Greenland, much valuable scientific work was done. Ethnology is the branch of science which has perhaps been most advanced. The Northern Eskimo, the Arctic Highlanders of Sir John Ross, have been most thoroughly studied and photographed. The entire tribe numbers some 250 individuals, every one of whom is personally known to Mr. Peary. They have lived quite untouched by civilisation, and free even from communication with the Southern Eskimo. They are of good physique and, while far from attractive in appearance or customs, they possess many good qualities.

Mr. Peary, as the result of his experience of these people and of the conditions of Arctic travel, has formulated a scheme of progressive exploration which he will put into practice next year. Equipped by funds that are already provided, he proposes to take a ship up to Sherard Osborn Fjord in latitude 82°, taking two other white men and a picked group of eight or ten Eskimo with all their belongings. They will send the ship back and form a camp, advance by the autumn moonlight along the coast, and winter as far north as possible. In the following year the northward march would be resumed until the furthest point of land was reached. This he hopes to find in 85°, if not even further north. From the camp at that point as a base a rapid journey must be attempted over the sea ice to the pole and back, leaving most of the Eskimo behind. If the first year did not afford an opportunity the next year might, or at least the third. Mr. Peary's principle is to wait for favourable conditions, and he is prepared to remain at his most northerly camp five years if necessary. In the course of that time he believes that a door to the pole will open, or can be pushed open. This principle has always been approved by the leading Arctic men, and recent experience has amply confirmed the importance of not struggling against obstacles when it is possible, by skill or patience, to take advantage of natural aids.

Mr. Peary's project has in it nothing sensational; he holds no prospect of startling discovery before the public; and the fact that his expedition is already provided for, obviates any necessity for making an appeal for financial support. The enthusiastic character of his reception by a large and deeply interested audience can only be paralleled in recent years by the greeting accorded to Dr. Nansen.

NOTES.

IT has been decided that the statue of Lavoisier, for which international contributions have been subscribed, shall be erected on the Place de la Madeleine, Paris. The Municipal Council of Paris have sanctioned this site.

M. DITTE, professor of chemistry at the Sorbonne, has been elected a member of the Section of Chemistry of the Paris Academy of Sciences, in succession to the late M. Schützenberger.

PROF. F. R. JAPP, F.R.S., will deliver the Kékulé Memorial Lecture at the Chemical Society next Wednesday evening, December 15.

AT the next meeting of the Royal Photographic Society on Tuesday, December 14, Prof. Gabriel Lippmann will read a paper on "Colour Photography." The meeting will not be held in the usual rooms at Hanover Square, arrangements having been made for it to take place in the theatre of the Society of Arts; a large gathering is anticipated. Non-members of the Royal Photographic Society will require admission tickets, which can be obtained on application to the Secretary at 12 Hanover Square.

WE regret to see the announcement that Prof. Winnecke, the distinguished astronomer, died on Friday last at Bonn.

LORD STRATHCONA AND MOUNT ROYAL, High Commissioner for Canada, will preside at Prof. Roberts-Austen's lecture on "Canada's Metals" at the Imperial Institute next Monday evening (December 13). The lecture, which will be fully illustrated by experiments, is open to the public, without tickets.

IT has been resolved to hold an international fisheries exhibition in Aberdeen in the summer of 1899.

A SKELETON of the moa was sold at Mr. J. C. Stevens' auction rooms on Tuesday, the price reached being forty-eight guineas. The bird was set up by Captain F. W. Hutton, F.R.S., from bones obtained at Enfield, New Zealand. The deposits in which these *Diornis* remains were found was described by Dr. H. O. Forbes in NATURE of March 3, 1892 (vol. xlv. p. 416).

A GENERAL meeting of the Aeronautical Society of Great Britain will be held on Thursday, December 16, at 8 p.m., at the Society of Arts, John Street, Adelphi, W.C. Major-General Sir Charles Warren, G.C.M.G., K.C.B., will occupy the chair. The following gentlemen and others have kindly arranged to exhibit apparatus:—Mr. Pilcher, a soaring machine and an oil engine; Major Moore, a model flying machine; Mr. E. S. Bruce, balloon signalling apparatus; Captain Baden-Powell, kites and a gliding machine; the Society, cinematograph of flying birds.

WHEN a large number of crickets are chirping at night in a field, they do so synchronously, keeping time as if led by the wand of a conductor. Prof. A. E. Dolbear says, in the *American Naturalist*, that the rate of chirp seems to be entirely determined by the temperature, and this to such a degree that the temperature can be estimated when the number of chirps per minute is known. At a temperature of 60° F. the rate was found to be 80 per minute, and at 70° F. it was 120 a minute; this gives a change of four chirps per minute for each change of one degree.

THE following are among the lecture arrangements at the Royal Institution before Easter:—Prof. Oliver Lodge, six Christmas lectures (specially adapted for young people) on the principles of the electric telegraph; Prof. E. Ray Lankester, eleven lectures on the simplest living things; Prof. Dewar, three lectures on the halogen group of elements; Prof. J. A. Fleming, five lectures on recent researches in magnetism and diamagnetism; Prof.

Patrick Geddes, three lectures on Cyprus. The Friday evening meetings will begin on January 21, when a discourse will be given by the Right Hon. Sir John Lubbock, Bart., M.P., on buds and stipules. Succeeding discourses will probably be given by Prof. C. Lloyd Morgan, Mr. A. A. Campbell Swinton, Dr. J. Hall Gladstone, Prof. L. C. Miall, Captain Abney, Prof. T. E. Thorpe, Mr. James Mansergh, the Dean of Canterbury, Prof. Dewar, and others. Lord Rayleigh will deliver lectures after Easter.

AT the meeting of the General Medical Council last week, the Committee entrusted with the duty of preparing the new edition of the British Pharmacopœia, submitted copies of their draft of the work for the approval of the Council. The estimated amount to be expended on its production will be about 6000*l.* The Committee suggest that the price of the volume might suitably be seven shillings and sixpence, but the power of actually fixing the price rests with the Commissioners of the Treasury. In order that the Pharmacopœia might be issued early next year, the Committee recommended that it be delegated to the Executive Committee to adopt the fully corrected work as The British Pharmacopœia, 1898, to communicate with the Commissioners of the Treasury on the question of price, to publish the Pharmacopœia, and to make the usual legal announcement of publication. The report of the Committee was adopted.

THE difficulties in the way of a permanent establishment of the Essex Field Club's County Museum of Natural History have been very largely removed by Mr. Passmore Edwards' munificent offer to build a museum at West Ham (adjoining the new Technical Institute) to contain the Club's collections, on condition that the building is maintained by the Corporation of West Ham as a permanent institution, and that it is opened on Sundays. The Town Council have gratefully accepted Mr. Passmore Edwards' offer, and arrangements are being entered into whereby the annual upkeep of the museum will be provided for by a joint fund subscribed by the Corporation and the Club. The task of gathering the collections, and the scientific control of the same, will remain with the Club. The museum is intended to illustrate the county of Essex generally, while the Club's smaller museum in Queen Elizabeth's Lodge, Chingford, will be confined to objects from Epping Forest—the two institutions being mutually dependent and illustrative, the one of the other. Further details will be issued when the negotiations are completed.

AT the last meeting of the Council of the Australasian Association for the Advancement of Science, the following gentlemen were proposed as vice-presidents of Sections:—Section A (astronomy, mathematics, and physics), Prof. A. M'Aulay and Prof. T. R. Lyle; Section B (chemistry), Mr. R. T. Bellemey, Prof. E. H. Rennie, and Prof. Orme Masson; Section C (geology and mineralogy), Mr. W. Howchin and Mr. R. L. Jack; Section D (biology), Prof. J. T. Wilson, Prof. C. J. Martin, and Mr. J. J. Fletcher; Section E (geography), Mr. P. G. King and Mr. A. C. Macdonald; Section F (ethnology and anthropology), Prof. W. Baldwin Spencer, Mr. Thos. Worsnop, and the Rev. Lorimer Fison; Section G (economic science and agriculture), Dr. H. N. MacLaurin, Mr. R. Teece, Mr. W. M'Millan, Mr. Sydney Smith, Mr. E. M. Shelton, and Mr. W. Farrer; Section H (engineering and architecture), Mr. H. Deane and Prof. W. H. Warren; Section I (sanitary science and hygiene), Dr. D. Hardie, Dr. J. W. Springthorpe, and Dr. J. Ashburton Thompson; Section J (mental science and education), Dr. A. Garran, Dr. R. N. Morris, and Mr. R. H. Roe. A large number of additional papers were announced as having been promised to the various Sections.

THE Meteorological Council have published a very useful volume of Rainfall Tables for the years 1866–90, based upon observations at 492 stations, selected so as to show as nearly as possible the general distribution of rain over the United Kingdom. The present volume has been prepared in connection with the previous set of tables for 1866–80 published in the year 1883, and while it includes in the general averages the monthly and annual means of the earlier series, it contains the separate monthly and yearly values for each of the years 1881–90, and of any years prior to 1881 which were not previously published. To facilitate the use of the tables, references to them are arranged both under counties and stations. There is no discussion of the observations, but the averages for the years 1881–90 are shown upon three maps, together with the main watersheds and the catchment basins of the principal rivers, and these exhibit the general distribution of the rainfall very clearly. The whole work has undergone careful supervision, and will be very valuable as a standard of reference in this branch of meteorological statistics.

THE meteorological observations made at the Rousdon Observatory, Lyme Regis, during last year, have been brought together by Mr. Cuthbert E. Peek, and published in the form of a Report. The observatory is a second order station of the Royal Meteorological Society. Mr. Peek not only describes the meteorological conditions and statistics of the different months of the year, but also records the results of a number of experiments to compare rain-gauges and anemometers of different kinds. A daily comparison of the actual weather experienced at the observatory with the forecasts of the Meteorological Office showed that, taking wind and weather together, eighty-eight per cent. of the forecasts were correct. Of wind alone, ninety-one per cent. of the forecasts were fulfilled; and of weather, ninety-two per cent. The most trustworthy forecasts were in August, there being only one day doubtful during that month. The lowest percentage of trustworthy forecasts was in January, as might be expected from the remarkable barometric movements of that month. A comparison of forecasts and actual wind and weather for the thirteen years 1884–96, shows that the percentage of successes was only fifty-nine in 1884, but in the following years it reached seventy per cent., and has been increasing year by year ever since. The best forecasts seem to have been made in 1894 and 1895, in which years eighty-nine per cent. of the predictions were fulfilled.

DR. VAN DER STOK, the Director of the meteorological and magnetical observatory of Batavia, has published a very comprehensive atlas, containing a large amount of information on the winds, weather, currents, &c., of the East Indian Archipelago. Some idea of the magnitude of the work may be formed from the fact that it extends to more than two hundred large folio pages of tables and charts, and that it embraces the whole area between the western coast of Sumatra and the northern coast of New Guinea. For forty different points of this area the meteorological conditions have been deduced for each month and for seasons, while monthly wind-roses have been drawn for the day and night separately. The work is divided into three parts: (1) observations made on ships; (2) rainfall and wind observations made on land; and (3) data relating to tides. The materials made use of in the first part have been extracted from many hundreds of log books kept on Dutch men-of-war during the years 1814–1890, and were obtained from the Ministry of Marine at the Hague for the purpose of this discussion. The work is a valuable contribution to both the physical geography and meteorology of that portion of the globe, and will be of great practical use to navigators.

THE first occasion upon which Röntgen rays were applied to surgical diagnosis was referred to by General Maurice in the course of a few remarks made at the close of a lecture delivered at the Royal Artillery Institution, Woolwich, by Mr. J. W. Webster. The credit of having first used the rays to determine whether a patient (who had severely injured his elbow) was suffering from a fracture or a dislocation, has hitherto been given to Mr. Howard Marsh. It appears, however, that Mr. Marsh really only recommended the application of the rays to the case, and that the actual photograph was taken by Mr. Webster, who had been working for some time with Mr. T. Moore. The photograph showed distinctly that the injury was due to a dislocation, and was not a fracture at all. The diagnosis having been established, the operation of putting the arm in its place was performed by Captain Salvage, an army surgeon. Mr. Howard Marsh described the case in the *British Medical Journal;* but, says General Maurice, "as he was simply dealing with it as a scientific case, the names of Mr. Webster and Mr. Moore were, according to professional etiquette, necessarily omitted." The lecture from which we gather these facts appears in the *Proceedings* of the Royal Artillery Institution (No. 5, vol. xxiv., 1897).

THE Annual Report for 1896 of the State Board of Health of Massachusetts has just been issued. The work of the now historic series of experimental filters has been recorded as usual, and there is but little to add to the deductions already published in previous years regarding their respective efficiency in the purification of water. The presence of iron in public water supplies has been engaging the attention of the Board, and experiments have been started which, as far as they have gone, indicate that this evil may be remedied by filtering water through a fine filter of coke breeze, which is stated to practically remove all the iron. Another important matter which has been investigated is the purification of manufacturing refuse; such factory-sewage may contain several times as much organic matter as an equal volume of domestic sewage, and is extremely difficult to deal with; in many cases the chemicals used in manufacturing processes being such as would destroy nitrification if the sewage were applied to an ordinary sewage filter. The dissemination of typhoid fever through the use of polluted water in ponds in the vicinity of so-called "picnic groves"—places of summer resort brought within easy reach of large cities by the extension of electric railways—has also been carefully inquired into, and the sanitary conditions of a large number of such resorts and their water-supplies have been investigated. Other matters dealt with in the Annual Report are the production and use of diphtheria antitoxin; an experimental inquiry as to the diagnosis, genesis and diffusion of malaria; examinations of sputum and other material suspected of containing tubercle bacilli, &c.

AT the meeting of the Chemical and Metallurgical Society of South Africa, held on October 16 last, some interesting data on dry crushing and direct cyaniding of Rand ore were given by Mr. Franklin White. Great things were expected of this method of treatment by some metallurgists a year or two ago, but its progress has been far from rapid, largely owing, no doubt, to the comparatively low percentage of gold extracted by its use. According to Mr. White, however, 917 tons of oxidised ore from Botha's Reef, treated recently, yielded 65·77 per cent. of its gold, the tailings containing 2·708 dwts. per ton. The only preparation of the ore was to pass it through a Gates crusher, after which nearly 20 per cent. remained on ½-mesh screens. Experiments seem to show that if the material had been passed through ⅛-mesh screens, about 76 per cent. of the gold would have been extracted in one operation. About 1000 tons of pyritic ore from the Village Main Reef were also experimentally treated with evcellent results; one charge giving a theoretical extraction of 89·25 per cent., as deduced from the difference in the assays before and after treatment. The cheapness and simplicity of the process is much in its favour. In another paper read at the same meeting, Mr. Wilkinson estimated the present total costs of twenty-nine Rand outcrop mining companies as averaging only about 26*s.* per ton for mining, milling, development, &c., or about 4*s.* per ton less than in 1896, when the native wages were higher. A further reduction in cost of 4*s.* or 5*s.* per ton would be accompanied by an enormous increase in the profits. The life of the gold field is estimated at fifty years, and its average yield during that period at about 18,000,000*l.* per annum.

IT is stated in *Engineering* that a company of considerable importance and with an influential board has just been formed in Sweden for the purpose, principally, of exploiting, through electric transmission, the vast unused power of the famous Trollhättan waterfalls, situated at some distance from Gothenburg, Sweden. The new company is to take over Dr. de Laval's waterfalls and property at Trollhättan, a carbide manufactory at Okan, with turbines and other installations, the Edenäs waterfall in Upper Lulea, and certain of De Laval's patents and inventions. There are in both places considerable areas of land, while the water-power at Trollhättan is estimated at 220,000 horse-power, and that at Edenäs at 100,000 horse-power. There is consequently both power and space enough for industrial installations on a large scale. It is intended to build a tunnel at Trollhättan, which is to receive the water above the falls in question (for there are others above it, already partly utilised) just above the "King Oscar Bridge," through which the tunnel will lead to a power station below the "Hell Fall." It is proposed to take some 20,000 to 30,000 electric horse-power through this tunnel. Of this power the company proposes as soon as possible to make available 10,000 horse-power, of which half has already been let to a well-known electrical engineer for a period of fifteen years. Of the 3000 horse-power (effective) at Okan, a portion is already being used for the manufacture of carbides.

A SURVEY of the conditions of artificial flight, and the experiments which have been made in connection with it, is contributed to the current number of *Science Progress* by Prof. G. H. Bryan, F.R.S. It is pointed out that every one of the conditions for successful flight has been fairly satisfactorily dealt with by various experimenters; and it only remains to embody them all in a single machine. The directions in which the solution of the problem should be sought are thus summarised by Prof. Bryan:—"If any experimenter can so thoroughly master the control of a machine sailing down-hill under gravity as to increase the size of the machine and make it large enough to carry a light motor, and if, further, this motor can be made of sufficient horse-power, combined with lightness, to convert a downward into a horizontal or upward motion, the problem of flight will be solved. The first flights need not be long—a hundred yards, rising, say, twenty or thirty feet above the ground, will be sufficient; all else will be simply a matter of improving on the original model, and once success is assured workers will not be wanting. Another promising direction for success lies in an elaborate and exhaustive investigation of balance and stability, such as would allow of the safe use of motor-driven machines too large to be controlled by mere athletic agility. This might partially be acquired by experiments with models, gradually increasing in size till they were capable of carrying a man and a motor. But if the future development of artificial flight is not to continue a repetition of the chapter of accidents by which naval architects gained their theoretical knowledge, there is abundant work for mathematicians in reducing the conditions of stability of aerial machines

to a matter of pure calculation. One thing is certain, till this is done designs of large air-ships for the wholesale transport of passengers, officers and cargo are not of the slightest value; their designers would do better to study mathematics, and help in the heavy work of calculation still requiring to be done."

FOR the purpose of testing whether change of chemical structure ever results in change of weight, Landolt carried out a number of experiments in the years 1890–92. Using a variety of reactions, he made a careful series of weighings, both before and after chemical combination, of substances sealed in glass tubes, but the results were inconclusive. In three reactions with silver sulphate and ferrous sulphate, producing silver and ferric sulphate, the apparent loss of weight was, on the average, more than nine times as great as the probable error of weighing, and a similar apparent loss was indicated as the result of six reactions between iodic acid and hydriodic acid. In some other reactions, however, the observed change of weight was sometimes positive and sometimes negative. A similar set of weighings for another silver reaction closely related to the one used by Landolt have now been made by Fernando Sanford and Lilian E. Ray, and are described in the *Physical Review* (October). The reaction used was the reduction of silver from an ammonia solution of the oxide, by means of grape sugar. The weighings show greater irregularities than those of Landolt, but they are still accurate enough to justify the authors' conclusion that the reaction used by them was unaccompanied by any such change of weight as was observed in the similar reaction studied by Landolt.

THE September number of *Terrestrial Magnetism*, the publication of which has been unavoidably delayed, contains, among other contributions, a paper "Ueber die Fehler bei Erdmagnetischen Messungen," by H. Wild, and a translation of Prof. Max Eschenhagen's paper "On Minute, Rapid, Periodic Changes of the Earth's Magnetism," already noted in NATURE.

A COPY of an inaugural address on "Advances in Biological Science during the Victorian Era," recently delivered by Mr. Isaac C. Thompson as president of the Liverpool Biological Society, has been sent to us. The address is an instructive review of the most prominent biological work of the past sixty years, and the nature of it shows that the Liverpool Biological Society ranks high among the scientific bodies of the city.

MR. ALFRED HARKER'S excellent little guide to the study of rocks in thin slices under the microscope, published under the title "Petrology for Students" by the Cambridge University Press, has reached a second edition. The book has been revised throughout, and more attention has been given to American examples, at least among the igneous rocks. No better introduction to the study of petrology could be desired than is afforded by Mr. Harker's volume.

THE Essex Field Club will publish about Christmas, as one of their "Special Memoirs," a volume on the "Mammals, Reptiles and Fishes of Essex," by Dr. Henry Laver, one of the Vice-Presidents of the Society. Taken in conjunction with Christy's "Birds of Essex," issued by the Club in 1891, it will afford a complete guide to the vertebrate fauna of the county. The work will be illustrated by original drawings by Major Bale, of Colchester, and Mr. H. A. Cole, of Buckhurst Hill, depicting some of the more interesting species and their haunts in the county.

THE magnetic observations made at 509 places in Asia and Europe during the period 1867–1894, by Dr. H. Fritsche, Emeritus Director of the Russian Observatory at Pekin, have been brought together and published as a pamphlet in which the whole of the MS. is reproduced in facsimile. The first part of the pamphlet deals with the formulæ used in the calculation of horizontal intensity, and following it are tables showing the magnetic elements at 509 places in Europe, Siberia, and China, the longitudes and latitudes of the places being given, and also the dates of observation. Magnetic anomalies are discussed, and two local anomalies—one near the island of Ioussar-oe in Finland, and another near Moscow, are described in detail, and illustrated by three maps.

WITH reference to the note on p. 59 of our issue of November 18, as to the storm signals used by various maritime countries, which was based upon information contained in the U.S. Pilot Chart of the Pacific Ocean for November, we have received a note from Admiral Capello pointing out that, in addition to the use of flags of the Commercial Code and occasional semaphoric signals for the purpose of giving notice of the state of the weather between the Bay of Biscay, Madeira and Gibraltar, to passing vessels that may require it, the drum and cone signals adopted by the late Admiral FitzRoy are regularly hoisted at the semaphores to notify the probable approach of stormy weather.

THE additions to the Zoological Society's Gardens during the past week include a Black-handed Spider Monkey (*Ateles geoffroyi*, ♀) from Central America, presented by Mr. F. Colsell; two White-naped Weasels (*Pœcilogale albinucha*) from South Africa, presented by Mr. W. Champion; two Flat-backed Terrapins (*Cyclemmys platynota*) from Johore, Malay Peninsula, presented by Mr. S. S. Flower; two Chameleons (*Chamæleon vulgaris*) from North Africa, presented by Mr. Horace Dibley; two Ring-tailed Coatis (*Nasua rufa*), a Kinkajou (*Cercoleptes caudivolvulus*), a Punctated Agouti (*Dasyprocta punctata*), a Globose Curassow (*Crax globicera*) from British Honduras; two Vervet Monkeys (*Cercopithecus lalandii*, ♂ ♀) from South Africa, deposited; two Scaup Ducks (*Fuligula marila*, ♂ ♀), European, purchased.

DR. C. BÖRGEN asks us to state that in his letter on "The Law of Divisibility," which appeared in NATURE of November 18 (p. 54), he should have written $\Sigma(a_{v+a-1}$ instead of $\Sigma(a_{v-a+1}$.

OUR ASTRONOMICAL COLUMN.

METEORS (GEMINIDS).—The interest awakened by the recent expectation of a brilliant return of the Leonid meteors may induce many to make observations of other showers. It may be well, therefore, to remember that from the 9th to the 12th inst. the fairly good shower of the Geminids takes place. The radiant point is situated near Castor in R.A. 7h. and north declination 32°. In the years 1885 and 1892 there were remarkably good displays.

o CETI (MIRA).—In this column last week reference was made to the brightness of "Mira" near its maximum. Further observations made at the Solar Physics Observatory, South Kensington, show that, as at previous times, the light curve of this star is subject to fluctuations near maximum, but the star is still about the third magnitude, being considerably brighter than γ Ceti (3·38 N.O.U.). Only visual observations of the spectrum have been possible in consequence of the troubled state of the weather, which has not allowed of the long exposures necessary to secure the violet portion of the spectrum; the visual observations show the same bands as recorded by Sir Norman Lockyer at Westgate in 1888 (NATURE, vol. xxxviii. p. 61). This year the star will be well situated for observation for a considerable time after its brightest period, before being lost in the twilight, as it is now on the meridian about 9.30 p.m. We hope later to be able to give some additional facts as to the change which takes place in the invisible portion of the spectrum in passing from maximum to minimum.

THE COMPANION OF SIRIUS.—Prof. Burnham, using the 36-inch Lick refractor, was the last to observe the companion of Sirius before its perihelion passage. The observation was by no

means an easy one, the distance being measured as 4″·19 (1890 April 22). Since that date, especially during the last two years, several observers have attempted to catch a glimpse of this body with varying results. Dr. See, in a communication on this subject (*Astr. Journal*, No. 418), points out that although several objects have been measured which were thought at the time to be the companion in question, there seems to be evidence to show that in some cases these were spurious. There is, however, no doubt that the companion can now be seen, and several measures show that it is following with great accuracy the orbit which Dr. See computed for it in his work on "Researches on the Evolution of the Stellar Systems" (vol. i. p. 84). The satisfactory agreement of the observed and computed positions shows that this orbit is of a high degree of accuracy, and will be serviceable for many years to come. The following ephemeris, taken from Dr. See's paper, gives the position angles and distances for the next three years:—

	Pos. angle.	Distance.
	°	″
1897·70	174·5	4·59
1898·20	169·0	4·72
1899·20	158·9	4·97
1900·20	149·5	5·25

A LIBERAL GIFT TO ASTRONOMY.—It was briefly announced in last week's NATURE that Miss Alice Bache Gould, daughter of the late Dr. Gould, had entrusted to the U.S. National Academy of Sciences a fund of 20,000 dollars; we are now able to state the precise conditions under which the gift was made. The money given by Miss Gould is to be known as the Benjamin Apthorp Gould Fund, and the net income of the fund is to be expended under the direction of Prof. Lewis Boss of Albany, Dr. Seth C. Chandler of Cambridge, and Prof. Asaph Hall of Washington, who are constituted by Miss Gould a board of directors for that purpose. The income is to be devoted to the prosecution of researches in astronomy by assisting observers and investigators in such manner and sums as may be agreed upon by all three of the directors.

In a letter to the directors, Miss Gould writes:—"My object in creating the fund is two-fold; on the one hand to advance the cause of astronomy, and on the other to honour my father's memory and to ensure that his power to accomplish scientific work shall not end with his own life. . . . Throughout my father's life his patriotic feeling and scientific ambition were closely associated, and I wish therefore that a fund bearing his name should be used primarily for the benefit of investigators in his own country or of his own nationality. I recognise, however, that sometimes the best possible service to American science is in the maintenance of close communion between the scientific man of Europe and of America, and that therefore, even while acting in the spirit of the above restriction, it may occasionally be best to apply this money to the aid of a foreign investigator working abroad."

One idea in the creation of the fund is that it may relieve the directors of the Bache fund of the Academy of some of their astronomical expenses, so that they may be able to devote more of their money to other departments. Miss Gould expresses a strong wish that astronomy of precision shall be distinctly preferred to work in astrophysics, first, because of Dr. Gould's personal preference, and, second, because of the existence of endowments for astrophysics. The fund is distinctly intended for the advancement and not for the diffusion of scientific knowledge; actual expenses of investigation are to be considered rather than the personal support of investigators, and the directors are advised not to cover with their grants the field provided for by existing endowments.

CORAL BORING AT FUNAFUTI.[1]

THE boring at Funafuti, according to the latest advices, had reached a depth of 643 feet. Prof. David's report is transcribed from notes made during the progress of the work, and gives his first impressions of the materials brought up, down to a depth of 557 feet, which had been reached when he quitted the island to return to his duties at Sydney, leaving the work in charge of his assistant. The latest advices informed him that the boring was arrested at 643 feet, but as it was hoped this was only for a time, we are daily expecting to hear yet more gratifying news. His last letters, received during the present week, give a few particulars of the materials pierced between 557 and 643 feet. The work, states Prof. David, often presented most serious difficulties, which would probably have frustrated their efforts, but for the experience gained on the former occasion.

The bore-hole is situated about half a mile north-east of the Mission Church, and its height above sea level is about 1 foot above high water mark at spring tides. The diameter is 5 inches down to 68 feet; it is lined with 5-inch tubing down to 118 feet, and 4-inch from surface to 520 feet, so that on September 6 a 4-inch core was being obtained.

The following is a general description of the materials pierced:—For about a yard at the top there was a hard coral breccia. This was followed down to a depth of 40 feet by "coral reef rock," into the composition of which *Heliopora cerulea*, with spines of echinids and nullipores entered largely, the last predominating over the coral at from 15 to 20 feet. From 40 to 200 feet came more or less sandy material, but with a variable quantity of corals. These were scattered through the sand (calcareous and of organic origin; foraminifera, at about 40 feet, making from one-half to two-thirds of the whole) sometimes as fragments (forming occasionally a kind of rubble), but sometimes in the position of growth. Between 120 and 130 feet, and from about 190 to 200 feet, the material is described as fairly compact coral rock, so that very probably reefs *in situ*, though of no great thickness, were pierced at these depths. The sand appears to be largely derived from coral, but foraminifera occur, sometimes in abundance; so too do nullipores, and here and there spines of echinids. Towards 150 feet signs of change begin to appear in the corals, and these become more conspicuous as the boring approaches its greatest depth. In such case, if I understand rightly, some of the branching corals crumble away and are represented only by casts, while others remain, the surrounding matrix becoming solid, cemented apparently by calcite. Below 202 feet a decided change takes place in the character of the deposit. All above this seems to be largely composed of material derived from corals, with occasional rather brief interludes of true reef; and this mass, measuring, as said above, rather over 200 feet in thickness, may be termed the first or uppermost formation. Below this, down to about 373 feet, sandy material distinctly dominates, which sometimes is almost a calcareous mud. Still even there coral fragments and rubble ocoasionally appear, and now and then a few isolated corals. Other organisms may be detected, including nullipores, foraminifera, and mollusca; but until this material has been examined microscopically, it would be premature to attempt any precise statement. This mass, in thickness about 170 feet, may be termed the second or middle formation. It is not reef, though obviously produced in the vicinity of a reef. Below 370 feet is the third or lowest zone; in this beds composed of broken coral become frequent, which are intercalated with masses of dead coral, though sandy bands also occur. The character of the material suggests that it has been formed in the immediate vicinity of a reef, which has occasionally grown out laterally, though only for a time, and has built up a layer of true reef, from 2 to 3 feet in thickness, upon a mass of detrital coral. In one place the rock is specially noted as "hard," and hereabouts even the shells of gastropods have perished, only their casts remaining. From 526 to 555 feet the bore passed through fairly compact and (in places) very dense and hard "coral limestone" and "cavernous coral rock," in which dendroid forms were numerous. As regards the part between 557 feet and 643 feet only brief information is to hand, but Prof. David states that it is reported to be chiefly coral limestone, hard and dense, with occasional soft bands of coral sand or coral rubble. Thus the third, or lowest zone, about 270 feet in thickness, corresponds apparently with the first, but it seems to contain larger and more numerous masses of true reef.

Prof. David has also forwarded with his latest letters a section of the boring and of the exterior form of the island, down to about 730 fathoms: the one drawn from his notebook, the other from Captain Field's record of soundings. From this I gather the following particulars:—The bore-hole is, roughly speaking, rather over 100 yards from the margin of the ocean, and about 165 yards from that of the lagoon; it is about 240 yards from the spot where a sounding of 10 fathoms was obtained,

[1] "Summary of Prof. Edgeworth David's Preliminary Report on the Results of the Boring in the Atoll of Funafuti." Communicated by Prof. T. G. Bonney, F.R.S., Vice-Chairman of the Coral Reef Boring Committee. Read at the Royal Society, November 25.

nearly 400 yards from a 36-fathom sounding, and rather more than a quarter of a mile from one of 130 fathoms. After this the submarine slope, for a considerable depth, is not quite so steep. He also states that, at Funafuti, the vigorous growing portion of the reef appeared to be limited to within about 40 feet of the surface.

It would be premature, as Prof. David remarks, to express an opinion as to the theoretical bearing of these results until the core has been thoroughly studied. But two things seem clear, (1) that true reef has been pierced at depths down to more than 600 feet, and (2) that throughout the whole of the time represented by the mass which has been tested, coral must have grown in great abundance in some part or other of the locality now represented by Funafuti; for the atoll, it must be remembered, is surrounded by water about 2000 fathoms deep, which would completely isolate it from any other coraliferous locality.

THE VITALITY OF REFRIGERATED SEEDS.[1]

A CONSIDERABLE difference of opinion still exists amongst biologists as to the condition of the protoplasts of resting seeds, spores, &c., in which all ordinary signs of life may be unrecognisable for a considerable period.

According to one view, the essential elements of the cell, during the period of inertness, are still undergoing feeble but imperceptible alteration, accompanied by gaseous exchange with the surrounding atmosphere; and, even when ordinary respiration is in abeyance, it is assumed there are small internal changes going on, due to the interaction of certain constituents of the protoplasm, reactions which may be independent of the outside gaseous medium, and which are often referred to under the somewhat vague term of "intramolecular respiration."

On the other hand, it is sometimes maintained that all metabolism is completely arrested in protoplasm when in the dormant state, and that it then loses, for the time being, all power of internal adjustment to external conditions.

According to one view, therefore, the machinery of the dormant protoplasts is merely "slowed down" to an indefinite extent, whilst according to the other it is completely brought to rest for a time, to be once more set going when external conditions are favourable.

It appears to us that the advocates of the "slowing-down" hypothesis have scarcely given sufficient attention to the experimental evidence available, and that they have been somewhat biassed by a supposed analogy between the dormant state of seeds and the hibernating state in animals, and have also, perhaps, been unconsciously influenced by Mr. Herbert Spencer's well-known definition of life, which implies a constant internal adjustment in the living protoplasm.

The experiments of the late G. J. Romanes, which were described in a short paper laid before the Society in 1893 (*Roy. Soc. Proc.*, vol. lvii. p. 335), are full of interest in their bearing on this question. Seeds of various plants were submitted in glass tubes to high vacua of 1/1000000 of an atmosphere for a period of fifteen months. In some cases, after the seeds had been *in vacuo* for three months, they were transferred to other tubes charged respectively with oxygen, hydrogen, nitrogen, carbon monoxide, carbon dioxide, hydrogen sulphide, aqueous vapour, and the vapour of ether and chloroform. The results proved that neither a high vacuum, nor subsequent exposure for twelve months to any of the above gases or vapours, exercised much, if any, effect on the subsequent germinative power of the seeds employed.

These experiments of Romanes are certainly of the highest importance, since the seeds were submitted for a long period to conditions which must certainly have excluded anything like respiration by ordinary gaseous exchange, but the conditions did not preclude with the same certainty the possibility of chemical interactions of some kind or other within the protoplasm, those ill-understood changes, in fact, which have been referred to "intermolecular respiration." It is true that in some of the experiments, notably those in which the vapours of chloroform and ether were employed, the probability of any such internal reactions is rendered somewhat remote; but still, in most cases, the experiments admit of the possibility of feeble metabolic activity continuing in the cytoplasm.

It occurred to us, some months ago, that more evidence would probably be forthcoming on these points if we could submit seeds to a temperature below that at which ordinary chemical reactions take place, thus eliminating any possibility of interactions between the constituents of the protoplasm.

Owing to the kindness of Prof. Dewar, who has been good enough to place the resources of his laboratory at our disposal, and to undertake this part of the work for us, we have been able to ascertain how far the subsequent germinative power of a considerable variety of seeds is affected by prolonged exposure to the very low temperatures produced by the slow evaporation of *liquid air*.

The seeds, enclosed in thin glass tubes, were slowly cooled, and immersed in a vacuum-jacketed flask containing about two litres of the liquid air, which was kept replenished so as to submit the seeds for 110 consecutive hours to a temperature of from − 183° C. to − 192° C. About ten litres of liquid air were required for the experiment.

The seeds had been previously air-dried only, so contained from about 10 to 12 per cent. of natural moisture. After the above treatment they were slowly and carefully thawed, a process which occupied about fifty hours, and their germinative power was then compared with control experiments made on other portions of the seed which had not been treated in any way.

The seeds experimented on were as follows:—

Hordeum distichon.	*Trigonella fœnum-græcum.*
Avena sativa.	*Impatiens balsamina.*
Cucurbita Pepo.	*Helianthus annuus.*
Cyclanthera explodens.	*Heracleum villosum.*
Lotus Tetragonolobus.	*Convolvulus tricolor.*
Pisum elatius.	*Funkia sieboldiana.*

These include representatives of the following natural orders:—Gramineæ, Cucurbitaceæ, Leguminoseæ, Geraniaceæ, Compositæ, Umbelliferæ, Convolvulaceæ, and Liliaceæ.

Some of the seeds are endospermous, others non-endospermous, and the reserve material consists in some cases of starch, and in others of oil or of mucilage.

Their germinative power, after being submitted to the low temperature, showed no appreciable difference from that of the controls, and the resulting plants, which were in most cases grown to full maturity, were equally healthy in the two cases.

In 1892 Prof. Dewar and Prof. McKendrick found that a temperature of − 182° C. continued for one hour is insufficient to sterilise putrescent substances such as blood, milk, flesh, &c., and that seeds would germinate after the action of a similar temperature for the same period of time (*Roy. Inst. Proc.*, 1892, vol. xiii. p. 699).

When we commenced our experiments we were unaware that any other observations of a similar nature had been made, but whilst they were in progress our attention was drawn to an important memoir by C. de Candolle,[1] in which the latent life of seeds is discussed in the light of a number of low temperature experiments made principally by himself and R. Pictet, and described at intervals in the Geneva "Archives."[2] In the earlier experiments of C. de Candolle and Pictet, made in 1879, temperatures of − 39° C. to − 80° C. were employed, and these only from two to six hours, whilst Wartmann in 1881 exposed seeds for two hours to − 110° C. without effect. In 1884 Pictet found that an exposure of various kinds of Bacteriaceæ for three days to − 70° C., and afterwards for a further period of thirty-six hours to − 120°, did not destroy their vitality, and in the same year Pictet and C. de Candolle exposed seeds to − 100° C. for four days with the same result. Pictet, in 1893, further extended his observations to various microbes, and also to a large number of seeds, and claims to have cooled them down without effect to nearly − 200° C., but he gives no details of the experiments, nor any indication of the length of time during which the cooling lasted. His conclusions, however, are that, since all chemical action is annihilated at − 100° C., life must be a manifestation of natural laws of the same type as gravitation and weight.

In his memoir of 1895 (*loc. cit.*) C. de Candolle discusses very fully whether we must regard the life of the resting seed as com-

[1] "Note on the Influence of very Low Temperatures on the Germinative Power of Seeds." By Horace T. Brown, F.R.S., and F. Escombe. (Read before the Royal Society, November 18.)

[1] *Archives des Sci. Phys. et Nat.*, Geneva, 1895, vol. xxxiii. p. 497.

[2] E. Wartmann, 1860, *Archives des Sci. Phys. et Nat.*, 1860, p. 277; C. de Candolle and Pictet, 1879, *ibid.*, vol. ii. p. 354: *ibid.*, vol. ii. p. 629; E. Wartmann, 1881, *ibid.*, vol. v. p. 340; R. Pictet, 1884, *ibid.*, vol. xi. p. 320; R. Pictet and C. de Candolle, *ibid.*, p. 325; R. Pictet, 1893, *ibid.*, vol. xxx. p. 293; C. de Candolle, 1895, *ibid.*, vol. xxxiii. p. 497.

pletely arrested for a time or merely temporarily slackened (ralentie), and he gives the results of some new experiments on seeds maintained at from $-37°$ C. to $-53°$ C. in the "snow-box" of a refrigerating machine for a period of 118 days. Most of the seeds resisted this treatment successfully, and the author concludes that after a sufficient interval of time has elapsed the protoplasm of the ripe seed passes into a state of complete inertness in which it is incapable either of respiration or assimilation, and that whilst in this condition it can support, without detriment to its subsequent revival, rapid and considerable lowering of temperature.

De Candolle then points out that if it really be a fact that the suspended life of a resting seed is in any way dependent on respiration we might expect this to be shown by submitting seeds to a barometric vacuum for some time. He does not appear to have followed out this suggestion, and is apparently unaware of the direct experiments on this point carried out by Romanes two years previously; he argues, however, that if ordinary respiration is a factor of any importance, this may be determined by immersing the seeds in mercury for such a length of time as to ensure the complete consumption of the small amount of oxygen contained within their tissues. It was found that when seeds of *wheat*, and of *Lepidium sativum* were thus treated, for periods varying from one to three months, their power of germination was not sensibly affected.

Although these last described experiments of C. de Candolle go far to show that any considerable amount of respiration is unnecessary for the maintenance of potential life in the protoplasm of resting seeds, they are not inconsistent with the view that some minute amount of gaseous exchange may be going on during the whole course of the experiment at the expense of the oxygen contained in the seeds at the time of immersion in the mercury. The results would have been far more conclusive on this point if it had been shown that the gaseous oxygen originally contained in the seed tissue had been completely used up in an early stage of the experiment. The experiments of Romanes, however, conducted with high vacua and atmospheres of various gases, leave no room for doubt on this question, and we must consequently abandon all idea of the dormant state of resting seeds having any necessary dependence whatever on ordinary respiratory processes. Neither set of experiments, however, excludes the possibility of molecular interchanges in the protoplasm itself, such molecular transpositions in fact as those which can often be induced in living cells placed under anaërobic conditions, and which are all exothermic in character, and generally, but not necessarily, attended with the liberation of more or less CO_2. The great value of the low temperature experiments we have described lies in the fact that such processes of autoxidation, and in fact any conceivable internal chemical change in the protoplasts, are rendered impossible at temperatures of $-180°$ C. to $-190°$ C., and that we must consequently regard the protoplasm in resting seeds as existing in an absolutely inert state, devoid of any trace of metabolic activity, and yet conserving the potentiality of life. Such a state has been admirably compared by C. de Candolle with that of an explosive mixture, whose components can only react under determinate conditions of temperature; as long as these conditions remain unfulfilled the substances can remain in contact with each other for an indefinite period without combining.

It appears to us that the occurrence of a state of complete chemical inertness in protoplasm, without a necessary destruction of its potential activity, must necessitate some modification in the current ideas of the nature of life, for this inert state can scarcely be included in Mr. Herbert Spencer's well-known definition, which implies a continuous adjustment of internal to external relations.[1] The definition doubtless holds good for the ordinary *kinetic* state of protoplasm, but it is not sufficiently comprehensive to include protoplasm in the *static* condition in which it undoubtedly exists in resting seeds and spores. The definition becomes in fact one of "vital activity" rather than of life.

[1] The following passage from the "First Principles" (Section 25) clearly shows that the author in constructing his definition had not anticipated the possibility of a *living* organism attaining a state of absolutely stable equilibrium. "All vital actions, considered not separately but in their *ensemble*, have for their final purpose the balancing of certain outer processes by certain inner processes. There are unceasing external forces tending to bring the matter of which organic bodies consist into that state of stable equilibrium displayed by inorganic bodies; there are internal forces by which this tendency is constantly antagonised, and the perpetual changes which constitute life may be regarded as incidental to the maintenance of the antagonism."

As it is inconceivable that the maintenance of "potential vitality" in seeds during the exposure of more than 100 hours to a temperature of $-180°$ to $-190°$ C. can be in any way conditioned by, or correlated with, even the feeblest continuance of metabolic activity, it becomes difficult to see why there should be any time-limit to the perfect stability of protoplasm when once it has attained the resting state, provided the low temperature is maintained; in other words an immortality of the individual protoplasts is conceivable, of quite a different kind from that potentiality for unending life which is manifested by the fission of unicellular organisms, and with which Weismann has rendered us familiar.

In what manner and to what extent "resting" protoplasm differs from ordinary protoplasm we do not at present know, but there are indications, notably those afforded by the resting state of desiccated Rotifera, and also by some recent experiments of Van Eyck on discontinuous germination ("Ann. Agron," vol. xxi. (1895), p. 236), that ordinary protoplasts may, by suitable treatment, be brought to the "resting" condition.

In 1871, Lord Kelvin, in his Presidential Address to the British Association, threw out the suggestion that the origin of life as we know it may have been extra-terrestrial, and due to the "moss-grown fragments from the ruins of another world," which reached the earth as meteorites.[1] That such fragments might circulate in the intense cold of space for a perfectly indefinite period without prejudice to their freight of seeds or spores, is almost certain from the facts we know about the maintenance of life by "resting" protoplasm; the difficulties in the way of accepting such a hypothesis certainly do not lie in this direction.

We must express our thanks to Mr. Thiselton-Dyer and to Dr. D. H. Scott, for the facilities they have given us in carrying out these experiments in the Jodrell Laboratory.

Addendum.

After the completion of the above Note, our attention was called to a recent investigation by M. R. Chodat, on the influence of low temperatures on *Mucor mucedo* ("Bulletin de l'Herbier Boisier," vol. iv. (1896), p. 894). He found that a lowering of temperature for several hours to $-70°$ to $-110°$ C. failed to kill young spores of the mucor, and he adduces certain evidence, which is not, however, wholly convincing, that even the mycelium itself, when cultivated on Agar Agar, and whilst in active growth, is able to resist the action of these low temperatures. The author sums up his opinion as to the bearing of his experiments on the nature of life in the following words:—"La respiration elle-même est évidemment complètement arrêtée à cette température où les corps chimiques ne réagissent plus les uns sur les autres. Si l'on considère que la vie consiste principalement en un échange continuel de substance, soit par la nutrition intracellulaire, soit par la respiration, alors il faut convenir qu'à ces temperatures basses la vie n'existe plus. C'est une fatale erreur qu'on rencontre dans presque tous les traités que la respiration est une condition nécessaire de la vie, alors qu'elle n'est qu'une des conditions de sa manifestation. La vie est conditionée par certaines structures. Les forces qui les mettent en jeu peuvent être des forces toutes physiques. Elles sont simplement les sources d'énergie qui pourront mettre la machine en mouvement."

THE LAW OF CONDENSATION OF STEAM.

At the meeting of the Institution of Civil Engineers on Tuesday, November 30, an important paper was read on "The Law of Condensation of Steam," by Prof. Hugh L. Callendar, F.R.S., and John T. Nicolson.

In the discussion of steam-engine trials it had generally been assumed that the rate of condensation of steam on a surface was practically infinite, so that any surface in direct contact with the steam was immediately heated to the saturation temperature corresponding with the pressure of the steam. It had also been supposed that the amount of condensation under any given conditions was limited, either by the resistance of the film of condensed water to the passage of heat, or by the capacity of the

[1] We find that Prof. Dewar called attention in one of his Royal Institution lectures in 1892 to the bearing of his low temperature experiments with spores, &c., on this suggestion of Lord Kelvin's (see *Roy. Inst. Proc.*, 1892, vol. xiii. p. 699.)

metal or of the circulating water to carry off the heat. In many cases condensation was diminished by films of oil or grease, or by accumulations of hair, or by other incrustations or deposits, but these were not considered in the paper.

The authors found, on the contrary, as the result of their experiments on a steam-engine running under normal conditions, that a practically clean and dry metal surface was not immediately heated to the temperature of the saturated steam in contact with it, that the rate of condensation of steam was not infinite, but finite and measurable, and that the amount of condensation in any given case was limited chiefly by this finite rate of condensation, and could be calculated in terms of it.

The cyclical variations of temperature in the metallic walls of the cylinder, with each stroke of the engine, were measured by means of thermo-couples inserted at various distances from the inner surface. It was possible thus to deduce the amount of heat absorbed and given out by the metal, and to infer the quantity of steam condensed and re-evaporated at different points of the stroke. The temperature-cycles of the steam were simultaneously measured by a very sensitive platinum thermometer. The observations showed that the temperature of the steam in different parts of the cylinder differed in a systematic way from the saturation temperature as deduced from indicator diagrams.

In order to deduce the condensation from the observed temperature-cycles, it was necessary to determine the conductivity and specific heat of cast iron. A series of experiments were made upon a four-inch bar of cast iron, and the result found for the conductivity was nearly 30 per cent. smaller than that generally assumed.

At the lowest speed of the experiments, namely, forty-five revolutions per minute, the temperature of the surface of the metal at the end of the admission period was found to be never raised higher than within 20° F. of the temperature of the steam, and the rate of condensation at any moment was simply proportional to the difference between the temperature of the steam and the surface. The numerical value found for the rate of condensation was 0·74 B.T.U. per second per square foot of surface per degree Fahrenheit of difference between the temperature of the steam and the surface. This was equivalent to the condensation of 27 pounds of steam per square foot per hour at 300° F., for a difference of temperature of 10° F. Assuming this law, the total amount of condensation at any point of the stroke could be inferred by measuring the "Condensation Areas" on the temperature-cycle diagram, *i.e.* the areas included between the curves representing the temperatures of the steam and of the metal surface.

To compare the results thus found with the missing steam deduced from the indicator diagrams and the feed measurements, the leakage of the valve and piston was determined as nearly as possible under the conditions of running. It was found to be proportional to the difference of pressure and nearly independent of the speed through a considerable range. The usual test for leakage with the valve stationary was found to be of little or no value. From a comparison of leakage tests, it was inferred that a valve in motion, however well fitted, was subject to leakage of a definite type. The leakage took place chiefly in the form of water, by condensation and re-evaporation on the moving surfaces, and was directly proportional to the perimeter of the ports and inversely to the width of the bearing surfaces. The amount of condensation observed during the admission period in a single-acting non-condensing cylinder 10·5 inches in diameter with a stroke of 12 inches, was only 20 per cent. of the feed at a speed of 100 revolutions per minute. The smallness of this result was probably due to the early compression and the dryness of the steam supply. It was found that re-evaporation was completed very quickly, and that the walls were dry for the greater part of the cycle. It was inferred from the form of the temperature curves and from other evidence that the rate of re-evaporation was the same as that of condensation.

From the form of the law of condensation it was possible to make an important theoretical deduction with regard to cases in which re-evaporation was incomplete, and the walls remained wet throughout the whole cycle. Under these conditions the mean temperature of the walls should be the same as the time average of the temperature of the steam to which they were exposed, and the cyclical condensation was the maximum possible for the given steam cycle. If the extent of the clearance surfaces was known, this limiting value of the condensation in any case might be easily deduced from the indicator diagram. If the surfaces were dry during part of the stroke, the condensation was less than the limit, and it was necessary to know the mean temperature of the clearance surfaces in addition. Upon these views of the nature of condensation and leakage, the missing quantity of steam W in pounds per hour might be expressed by an equation of the general type, $W = S\ (t' - t°) + L\ (p' - p'')$,—where the first term represented condensation and the second term leakage, S being the equivalent clearance surface in square feet, and $t' - t°$ the mean difference of temperature, in degrees Fahrenheit, between the walls and the steam during admission reduced to one-half cut-off. L, the rate of leakage per pound difference of pressure $p' - p''$, might be taken to vary approximately as the product of the diameter and the square root of the normal piston-speed, for engines of different sizes. It would appear from this formula that the effect of leakage on the performance was relatively more important in small engines and at high pressures, and that the loss due to condensation was most effectively reduced by increase of piston-speed.

As an indirect verification of this law of condensation, the temperature of the clearance surface in cases in which water was present in the cylinder was measured, and was found to agree with that of the mean of the steam cycle. The amount of condensation was also correctly calculated in several cases of published tests in which sufficient data were available. The rate of condensation deduced was also directly verified by an entirely different method. The experiments gave approximately the same rate of condensation, and appeared to show that the water-drops condensed on the metallic surface, owing probably to their rapid action, did not appreciably diminish the rate. Assuming it possible to estimate the condensation occurring in any given case by the method indicated, from a knowledge of the indicator diagram and of the temperature and area of the clearance surfaces, it then became possible to determine the amount of leakage under the actual conditions of running.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Institution of Civil Engineers has resolved to exempt Bachelors of Arts who obtain honours in the Mechanical Sciences Tripos from the examination prescribed for the Associate Membership of the Institution.

The Managers of the John Lucas Walker Studentship have elected Mr. J. W. W. Stephens, of Caius College, to the studentship in Pathology, and Dr. Hamilton K. Wright, of McGill University, Montreal, to an Exhibition of the value of 50*l.*

The proposal to authorise the Examiners for the Natural Sciences Tripos Part II. to inspect the laboratory note-books of candidates for honours was carried in the Senate by forty-seven votes to eighteen.

Dr. H. A. Giles has been elected to the Professorship of Chinese. Dr. W. H. R. Rivers, of St. John's College, has been appointed University Lecturer in Physiological and Experimental Psychology. Mr. W. L. H. Duckworth, Fellow of Jesus College, has been recognised as a Lecturer in Anthropology.

The Walsingham Medals for research in Biology, including Physiology, have been awarded to Mr. V. H. Blackman, of St. John's College, and Mr. W. M. Fletcher, of Trinity College. The electors report that the essays of four other candidates were of a high order of merit.

The election to the Isaac Newton Studentship in Astronomical Physics will be held in the Lent Term 1898. Candidates must be Bachelors of Arts of less than twenty-five years of age on January 1. The studentship is of the value of 200*l.* a year for three years. Applications are to be sent to the Vice-Chancellor between January 14 and 24.

The University delegates to the International Congress of Hygiene at Madrid, next April, are Dr. Kanthack, Dr. D. MacAlister, and Dr. Anningson.

THE death is announced of Dr. Brownless, Chancellor of Melbourne University.

DR. H. H. HOFFERT has been promoted to a senior inspectorship under the Science and Art Department, and Mr. S. J. Cartlidge—at present head-master of the Hanley School of Art—has been appointed to the vacant inspectorship.

The London Technical Education Board will proceed in July next to award three junior scholarships in practical gardening, which will be tenable at the new School of Practical Gardening which has recently been opened at the gardens of the Royal Botanic Society in Regent's Park. This school has been established with the view of providing a complete course of instruction for lads who desire to become gardeners. The scheme of work, which has been drawn up by the Royal Botanic Society, combines thorough practical instruction in all the operations of gardening with theoretical instruction in botany and the nature of soils and manures. The course is arranged so as to extend over three years.

The list of entrance scholarships and exhibitions awarded at Pembroke, Gonville and Caius, King's, Jesus, Christ's, and Emmanuel Colleges, Cambridge, affords an indication of the comparative encouragement given to classics and science at the University. It appears from the list that the scholarships for classics have the value of 1360*l.* Mathematics comes second with scholarships amounting to the value of 640*l.*, and the natural sciences take the last place with scholarships having a total value of 390*l.* Considering that the Science Tripos is the largest, or nearly the largest, this seems a discouraging division of the scholarship fund. It is only fair to add that at Trinity and St. John's Colleges the authorities are far more liberal to science, the value of scholarships awarded for natural sciences at the former College being 330*l.*, and at the latter, 205*l.*

The *Times* of Monday contains a detailed report of a conference held on Saturday last at the rooms of the Society of Arts, Adelphi, to consider the expediency of further development in the constitution of the Royal Holloway College in the light of the founder's expressed desire that powers should ultimately be sought enabling the college to confer degrees on its students. Mr. Bryce, M.P., one of the governors of the college, presided, and there was a large and influential gathering of educationists. Papers were read by Mr. R. D. Roberts in favour of an application from Holloway College for a separate charter to enable it to confer degrees upon its students; by Mr. Strachan Davidson, of Balliol College, Oxford, in support of the establishment of a women's university, of which Holloway College should form a part; and by Mrs. Bryant in advocacy of the proposal that Holloway College should become an integral member of the new teaching University of London. A number of letters from prominent educationists were read, expressing their views on the subject. A discussion followed, in which Mrs. Henry Fawcett, Miss Emily Davies, Mrs. Sidgwick, of Newnham, Miss M. Gurney, Sir Joshua Fitch, Mr. H. Sidgwick, and others took part. There was a practical consensus of opinion against the proposal that Holloway College should give degrees; a great majority of the speakers were opposed to the creation of a separate University for women, and many of them were in favour of connection with the new London University.

The new Academic Hall of Edinburgh University, opened on Saturday last, is another testimony to the close and friendly connection which has always existed between the University and the city. In 1888, Mr. William M'Ewan, M.P. for the Central Division of Edinburgh, offered a sum of 40,000*l.* with which to build the Academic Hall, which had formed a part of the original plans of the new University buildings, which had already cost 250,000*l.* to complete. This offer Mr. M'Ewan afterwards, on its being made clear that the amount was inadequate if the hall was to be proportionate to the buildings already erected, agreed to increase to 62,000*l.*, which was the original estimate of the cost of the hall. As the scheme grew under the hands of the architect, artificers, decorators, and organ builders, the liberality of Mr. M'Ewan kept pace, and the hall, as it now stands completed, has cost him 115,000*l.* The gift is a noble one, and it provides a noble example of the interest which the citizens of Edinburgh take in the welfare of the University. In accepting the deed of conveyance, on behalf of the University, Mr. Balfour said: "I confess that I have seen with feelings of regret, sometimes almost amounting to shame, the extreme difficulty which there has been not merely in connection with Edinburgh, but in connection with other great seats of learning, to obtain from the liberality of a not illiberal public sufficient means to make our great British Universities all that British Universities should be. I fear that in this respect we can but ill stand comparison with our cousins of the United States. There, if my information is not incorrect, they have never failed to find men with the means and with the will to keep the institutions of higher education in their country abreast with the ever-growing necessities of such institutions; and the number of generous benefactors which America has been able to show may well cause some feeling of shame, I think, in us on this side of the Atlantic, speaking the same language, possessing the same culture, aiming at the same objects, but who have not always shown in pursuit of those objects the same uninterested generosity. The relations between Edinburgh and the University, always close, almost always friendly, have not been diminished by changes in the status of the University. In connection with this very hall, or rather with the surroundings and accessories to the hall, the city of Edinburgh has shown itself possessed of the same generous public spirit, the same desire to do everything in its power to promote the interests of this great seat of learning which it has shown throughout all the centuries since this University was first founded." Mr. M'Ewan's liberality and Mr. Balfour's remarks upon the relations between the city of Edinburgh and the University should furnish food for reflection to the citizens of London.

The *Technical Education Gazette* publishes a few particulars with regard to the entries in the various classes at the nine polytechnics which are in receipt of aid from the Technical Education Board of the London County Council. The most significant fact in connection with the polytechnics is that, notwithstanding the opening of four new large polytechnics during the four years that the Board has been at work, no diminution has been caused in the number of students attending the older institutions, but on the contrary, every one of the nine institutions shows an increase in the number of class entries for the present session. Thus the remarkable result has been brought about that, although these four new institutions show this session a total of over 8000 class entries, representing a total number of nearly 5000 individual students, yet the enrolment of these new students has not only not decreased the membership of the other older institutions but has actually stimulated their growth. It may be estimated that there are now in attendance at the evening classes of the nine polytechnics about 18,000 individual students, the great majority of whom are engaged in systematic courses of evening instruction under the direction of the principal of the institution where they are studying. If we take the class entries in detail according to the various branches of study, we find that the classes in the building trades show in almost every case an increase in the number of students. In the engineering trades there is likewise a very general increase in the attendance at the classes. The great demand that exists for evening instruction in electrical engineering is shown by the fact that in both the two polytechnics in the south-west district of London, the Battersea Polytechnic and the South-west London Polytechnic at Chelsea, the number of students has increased during the past year with remarkable rapidity. Another satisfactory instance of increase is shown in the classes in typography and letterpress printing. Perhaps the most remarkable fact of all is that the original polytechnic at Regent Street, which draws its students from all parts of the metropolis, and which might therefore have been expected to suffer from the growth of new institutions, continues not only to maintain its numbers but even shows a further increase on last year. Last year the number of individual students attending on November 1 was 5583; this year there were in attendance on November 1 as many as 5848, representing an increase of about 5 per cent. A very rapid development has taken place in the classes at the South-west London Polytechnic. So numerous are the entries this session for both the day and the evening departments, that the resources of the building are taxed to the utmost, and very serious inconvenience is being caused in some of the departments by the want of sufficient accommodation.

SOCIETIES AND ACADEMIES.

London.

Royal Society, November 18.—"Account of a Comparison of Magnetic Instruments at Kew Observatory." By Dr. C. Chree, F.R.S., Superintendent.

Last July, M. T. Moureaux, of the Parc Saint-Maur Observatory, near Paris, brought over to England the travelling instruments employed in his magnetic survey of France, and a comparison was made between these and the standard magnetic instruments at Kew Observatory.

The comparison serves to connect the standard instruments at Kew Observatory with the standard French instruments at Parc Saint-Maur, the latter, as M. Moureaux has had the goodness to inform the author, being in excellent agreement with his travelling instruments. Parc Saint-Maur may be regarded as the base station for M. Moureaux's great survey of France and Algeria. M. Moureaux's observations occupied the afternoon of July 26, and the forenoons of July 27, 28 and 29. On the afternoons of the last three days, observations were made with the Kew standard instruments by Mr. T. W. Baker, chief assistant at the Observatory. The observations, being made at different hours of the day, had to be connected through the intermediary of the curves from the self-recording magnetic instruments.

The means of the declination and inclination readings from the Kew instruments exceeded the means from M. Moureaux's instruments by 0′·5 and 2′·0 respectively, but the mean horizontal force reading from the Kew instrument was lower than M. Moureaux's by ·00012 C.G.S. unit. In calculating the last-mentioned element, M. Moureaux made use of new values of the constants of the French instruments, to be put into general use after January 1, 1898.

The comparison is utilised to extend a table ("Brit. Assoc. Report for 1896," p. 97) in which Prof. Rücker and Mr. W. Watson embodied the results of their comparison of the standard instruments at various English and Irish observatories, made by means of travelling instruments in 1895.

The results may be summarised as follows:—

Observatory	Departures from imaginary mean instrument of the five Observatories		
	Declination	(Hor. force) × 10^5 C.G.S. units	Inclination
Kew	+ 0′·2	− 1	+ 0′·2
Parc Saint-Maur.	− 0′·3	+ 11	− 1′·8
Falmouth	+ 1′·0	+ 17	+ 1′·8
Stonyhurst ...	− 0′·9	+ 5	− 2′·0
Valencia	+ 0′·2	− 30	+ 2′·0

"On *Spencerites*, a new Genus of Lycopodiaceous Cones from the Coal-measures, founded on the *Lepidodendron Spenceri* of Williamson." By D. H. Scott, F.R.S.

The fossils which form the subject of the present paper are Cryptogamic strobili, showing evident Lycopodiaceous affinities, but differing in important points from other fructifications of that family, so that it appears necessary to establish a new genus for their reception.

Two species are described, one of which (*Spencerites insignis*) is already known to us from the investigations of Williamson, who named it first *Lepidostrobus insignis*, and afterwards *Lepidodendron Spenceri*, while the other (*Spencerites majusculus*) is new.

In one of his latest publications, Williamson pointed out that it might ultimately be necessary to make his *Lepidodendron Spenceri* the type of a new genus. The separation thus suggested is now carried out, on the basis of a renewed investigation of the structure of this fossil.

Spencerites insignis is a pedunculate strobilus; the vegetative organs are not as yet identified. The specimens are calcified, and their structure admirably preserved.

The anatomy of the axis is of a simple Lycopodiaceous type, but differs in details (such as the course of the leaf-trace bundles) from that of the axis of *Lepidostrobus*. The peduncle bears sterile bracts, similar to the sporophylls of the cone itself; the latter are arranged spirally, or in some cases in alternating verticils.

The individual sporophylls are of peltate form, consisting of a short cylindrical pedicel, expanding into a relatively large lamina. The sporangia are approximately spherical bodies; unlike those of *Lepidostrobus*, they are quite free from the pedicel, and are attached by a narrow base to the upper surface of the lamina, where it begins to expand.

The details of the sporangial wall are quite different from those of *Lepidostrobus*, and the spores are also characteristic. In size they are intermediate between the microspores and macrospores of *Lepidostrobus*. They are of tetrahedral form, becoming spheroidal when mature, and each spore has a hollow, annular wing running round its equator. The wing is no doubt formed by a dilation of the cuticle, and not, as Williamson supposed, from the abortive sister-cells.

Spencerites majusculus, the new species, is much larger than the former, the axis of the cone being twice as thick. The anatomy is similar, but the sporophylls, and consequently the leaf-traces, are more numerous. The sporophylls, which are arranged in alternating verticils, are relatively short, and of peculiar form; the lamina is very thick, and of great tangential width. The sporangia are like those of the former species, and similarly inserted, but the spores are quite different. They are smaller than those of *S. insignis*, and have the form of quadrants of a sphere, with narrow wings along their three angles.

The genus is separated from *Lepidostrobus*, mainly on account of the very different mode of insertion of the sporangia, a character which is accompanied by differences in the form of the sporophylls and sporangia, the structure of the sporangial wall and of the spores, and the whole habit of the strobilus.

Spencerites, and especially *S. insignis*, bears a considerable resemblance to the *Sigillariostrobus Crepini*, of Zeiller, but cannot be united with the genus *Sigillariostrobus*, for the insertion of the sporangia in the latter, as shown in the *Sigillariostrobus ciliatus*, of Kidston, is totally different. The author is much indebted both to M. Zeiller and Mr. Kidston, for the loan of their specimens for examination.

Zoological Society, November 30.—Mr. E. T. Newton, F.R.S., in the chair.—Mr. Oldfield Thomas exhibited specimens of a remarkable partially white Antelope of the genus *Cervicapra*, which had been obtained by Mr. F. V. Kirby in the mountains of the Lydenburg district of the Transvaal, and read an account of them contributed by Mr. Kirby himself. Mr. Oldfield Thomas also exhibited a skin of a new Skunk of the genus *Spilogale* from Sinaloa, Mexico, proposed to be termed *Spilogale pygmæa*. It was interesting as being of barely half the size of any previously known species, and also differed from all its congeners in the median dorsal stripes being uninterrupted posteriorly, and in having white hands and feet.—Mr. Thomas likewise exhibited a Badger from Lower California, proposed to be termed *Taxidea taxus infusca*, which differed from the described forms of *T. taxus* in its dark coloration and broad nuchal stripe.—Mr. Sclater exhibited the head of a *Capra* from Arabia, which had been recently described as *Capra mengesi*. Mr. Sclater was inclined to believe that the specimen was referable to *Capra sinaitica*, in which opinion Mr. O. Thomas agreed with him.—Mr. R. E. Holding exhibited a pair of curiously deformed horns of the Fallow Deer, and made remarks on the associations between organic disease and defective horn-growth.—On behalf of Mr. R. Lydekker was exhibited a skin and antlers of a small form of the Mule Deer from Lower California, for which he suggested the name *Mazama hemionus peninsulæ*. It differed from *M. h. californicus* in its small size, black dorsal line, and in the reduction of white on the tail.—Mr. G. A. Boulenger, F.R.S., exhibited some specimens of a South-American Siluroid Fish (*Vandellia cirrhosa*), and made remarks upon its curious habits.—A communication from Mr. H. H. Brindley, on regeneration of the legs in *Blattidæ*, was read. It consisted of an account of the statistical and experimental evidence of the reproduction of lost or injured legs in the *Blattidæ*, obtained since the publication of Mr. W. Bateson's book, "Materials for the Study of Variation," in 1894, and of some points in the post-embryonic development of the Cockroach (*Periplaneta orientalis*).—Mr. G. A. Boulenger, F.R.S., read a paper on a gigantic Sea-perch, *Stereolepis gigas*. This fish was described both externally and internally, and the author pointed out that *Megaperca ischinagi*, Hilgendorf, was specifically identical with it. Mr. G. A. Boulenger also described a new Tortoise of the African genus *Sternothærus*, a specimen of which had lately been received at, and was still living in, the Society's Gardens. It was proposed to name it *Sternothærus oxyrhinus*.—A communication from Mr. W. E. Collinge, on the structure and affinities of some further new species of slugs from Borneo, was read. Three new species, namely, *Parmarion fultoni*, *P. flavescens*, and *Microparmarion constrictus*, were described, and the author intimated that Simroth's genus *Microparmarion* would, on examination of more material, probably be found to be of only sectional value.

EDINBURGH.

Mathematical Society, November 12.—Mr. J. B. Clark, Vice-President, in the chair.—Prof. George A. Gibson contributed a paper on the "Treatment of Arithmetical Progres-

sions by Archimedes," and communicated a paper by M. Lémeray, entitled "Quatrième Algorithme Naturel." The following were elected office-bearers for the current session:—President, Mr. J. B. Clark; Vice-President, Dr. Alexander Morgan; Hon. Secretary, Mr. J. W. Butters; Hon. Treasurer, Mr. D. Tweedie; Editors of *Proceedings*, Mr. W. J. Macdonald, Dr. Knott, Mr. Charles Tweedie; Committee, Messrs. G. Duthie, R. F. Muirhead, and J. D. H. Dickson.

Manchester.

Literary and Philosophical Society, November 30.—Mr. J. Cosmo Melvill, President, in the chair.—Mr. H. W. Freston (Prestwich) and Mr. C. E. Stromeyer (Manchester) were elected ordinary members of the Society.—The President announced that the Council had awarded the Wilde Gold Medal of the Society for 1898 to Sir Joseph Dalton Hooker, C.B., K.C.S.I., F.R.S., in recognition of his eminent services to all branches of botanical science; and had awarded the Dalton Medal of the Society (struck in 1864) for 1898 to Dr. Edward Schunck, F.R.S., for his remarkable series of researches on the natural colouring matters; also. that the premium for 1898 of fifteen guineas had been awarded to Mr. John Butterworth, of Shaw, for his paper, printed in the *Manchester Memoirs*, on some further investigations of fossil seeds of the genus *Lagenostoma* (Williamson).—Prof. H. Lamb read a paper entitled "On waves in a medium having a periodic discontinuity of structure." The main object of the paper is to examine the selective total reflection which takes place at the boundary of a medium of this character. In the examples chosen for discussion the medium is represented by a string supposed to be capable of longitudinal vibrations, and the periodic interruption of properties may consist in a series of attached masses, or of attached particles, which are, moreover, urged towards fixed positions by springs, or to particles connected with the string by loose springs. The same analysis applies to media constituted in many other ways, and it is further shown how the methods may be adapted to cases where dynamical systems of a much more general character are interpolated at regular intervals. There are some instructive contrasts between the results obtained in the special cases above enumerated; in particular, in the last-mentioned case (that of particles attached by loose springs) it appears that relatively short waves may be transmitted freely unless the wave-length happens to fall within certain narrowly defined intervals. We have here, perhaps, an illustration of the theory of refraction sketched by Sir George Stokes in the Wilde Lecture; but some caution is, of course, necessary in drawing inferences as to theories of radiation and absorption from the study of a one-dimensional model.

Paris.

Academy of Sciences, November 29.—M. A. Chatin in the chair.—New method of preparing carbides by the action of calcium carbide upon oxides, by M. Henri Moissan. Calcium carbide reacts with many metallic oxides at the temperature of the electric furnace, giving the carbide of the metal and lime, the latter being again partially converted into carbide by the carbon of the crucible. The carbides of aluminium, manganese, chromium, molybdenum, tungsten, titanium, and silicon were obtained by this method. The oxides of lead, bismuth and tin gave the pure metals on similar treatment.—Experimental typhoid infection, produced by the introduction of a virulent culture into a Thiry cavity, by MM. R. Lépine and B. Lyonnet.—M. Ditte was elected a Member in the Section of Chemistry, in the place of the late M. Schützenberger.—Report on a memoir of M. Le Roy, entitled "On the integration of the equations of heat."—Observations of the new planet Villiger (1897, November 19) made at the Observatory of Algiers, by MM. Rambaud and Sy.—On two occultations of the Pleiads by the moon, by M. Lagrula. The observations are utilised for the determination of the semi-diameter and parallax of the moon at its mean distance.—Employment of the method of least squares to reveal the presence of systematic errors, by M. Jean Mascart. The determination of the vertical by means of the meridian circle is subject to errors much larger than would follow from the possible error of each microscope reading. With a view to see how far these fluctuations were due to alterations of temperature, a series of fifty determinations was made, giving fifty equations of condition for each microscope for three unknowns, the deviations being assumed as a quadratic function of the temperature. The results showed, however, that the fluctuations due to temperature changes are extremely small, and that the comparatively large errors observed must be due to other causes.—Observations of the sun made at the Observatory of Lyons, with the Brunner equatorial, during the third quarter of 1897, by M. J. Guillaume.—Influence of altitude and of heat upon the decomposition of oxalic acid by sunlight, by M. J. Vallot and Mme. Gabrielle Vallot. It has been found that, although oxalic acid is practically undecomposed by heat alone, the velocity of the reaction with actinic light is very greatly accelerated by a rise of temperature. Thus two solutions of oxalic acid exposed to sunlight under similar conditions, except that one was maintained 12° higher than the other, gave decompositions of 10 and 50 per cent. respectively. The rate of decomposition also increased rapidly with the altitude.—On the fundamental theorem of projective geometry, by M. H. G. Zeuthen.—On the equation to periods, by M. X. Stouff.—On the Bessel functions $S^n(x)$ and $O^n(x)$, by M. L. Crelier.—On the statical and dynamical explosive potentials, by M. R. Swyngedauw. A reply to some criticisms of M. Jaumann.—A simple method of proving the change of period of sodium light in a magnetic field, by M. A. Cotton. A flame feebly tinged with sodium is observed through another flame also containing sodium. The edges of the second flame appear to be black, owing to its gaseous envelope being absorbent. Any small change in the period of vibration of the more distant flame, produced by the action of the magnetic field, suppresses the absorption, and causes the black border of the interposed flame to disappear. In this way it is easily shown that a change of period of light emitted parallel to the lines of force, completely extinguishes the dark border, whilst with observations made perpendicularly to the lines of force, the border grows lighter on completing the circuit round the magnet, but does not completely disappear.—Osmotic researches on very dilute solutions of cane sugar, by M. Ponsot. The author was successful in making membranes impermeable to sugar. With these measurements of osmotic pressure were made of sugar solutions containing only 1·235 and 0·6175 grams per litre. The mean of the observed pressures was exactly equal to that calculated by the Van t' Hoff formula, on the assumption that no dissociation of the sugar took place, or the coefficient $i = 1$.—On the alcoholic isocyanurates and the constitutional formula of cyanuric acid, by M. Paul Lemoult. The heats of combustion of methyl and ethyl isocyanurates were determined, and the conclusion drawn that isocyanuric acid has a ring-shaped constitution, a symmetrical tricarbimide.—Quinones and hydroquinones, by M. Amand Valeur. Determinations of the heats of combustion of toluquinone, thymoquinone, hydroquinone, hydrotoluquinone, and hydrothymoquinone.—On the transformation of sorbite into sorbose by the *Mycoderma vini*, by M. A. Matrot. The best experimental conditions for the production of sorbose from sorbite by means of the yeast *Mycoderma vini* are worked out in detail.—On the germinative plates of the Coleoptera, by M. A. Lécaillon. For certain Coleoptera it is shown that the blastula stage does not appear in development, the gastrula stage following immediately upon segmentation, and showing no typical invagination.—On the *Rouget*, a human parasite, by M. Brucker. This parasite, which appears as a parasite to man in August and September, is shown to be probably the larva of *Trombidium gymnopterorum*.—On the culture of the nostoch in presence of glucose, by M. Raoul Bouilhac.—On the characteristics of nerve and muscle stimulation, by M. G. Weiss. A reply to the criticisms of M. Dubois. The author claims that the experiments cited by M. Dubois are in reality confirmatory of his views.—Analysis of vocal sounds by the phonograph, by MM. Marichelle and Hémardinquer. In spite of the various influences which act upon the form of the period, such as musical pitch, intonation, intensity, and individual conformation of the sounding organ, each vowel is distinguished by certain invariable characters, constituting it a real individual.—On the absorption of organic materials by roots, by M. Jules Laurent. Experiments were made with maize upon solutions of glucose and invert sugar, and in every case a certain quantity of the sugar was absorbed by the roots, the amount of which appeared to be proportional to the dry weight of the plant. The sugars are utilised by the plant, and in great part excreted as carbon dioxide.—The favourable times in the treatment of black rot, by M. A. Prunet. A treatment with copper salts applied immediately after one invasion of the disease, acts beneficially against a future invasion, the maximum effect being pro-

duced by treating the vine from five to eight days after the first appearance of the spots.—On the rational construction of mills with metallic rollers, by M. J. Schweitzer.—On the analysis of silicates, by M. A. Leclère. The conditions are prescribed under which silicates may be safely opened up in a platinum crucible by means of lead oxide, the chief points being the purity of the oxide, and the complete exclusion of reducing gases by the use of a muffle.—On some peculiar circumstances which appear to have accompanied the fall of a meteorite on April 9, 1891, at Indarck in Transcaucasia, by M. Stanislas Meunier.—On the contamination of the springs of Sauve (Gard), by M. E. A. Martel. The contamination of the water supply of Sauve by sewage was proved directly by means of fluorescin. The frequent epidemics which have decimated this town are thus explained.—On two radiographs of the thorax, by M. F. Garrigou.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 9.

ROYAL SOCIETY, at 4.30.—On the Densities of Carbonic Oxide, Carbonic Anhydride, and Nitrous Oxide: Lord Rayleigh, F.R.S.—On the Application of Harmonic Analysis to the Dynamical Theory of the Tides. Part II. On the General Integration of Laplace's Dynamical Equations: S. S. Hough.—A. Note on some Further Determinations of the Dielectric Constants of Organic Bodies and Electrolytes at Very Low Temperatures: Prof. Dewar, F.R S., and Prof. Fleming, F.R.S.—On Methods of making Magnets independent of Changes of Temperature, and some Experiments upon Negative Temperature Co-efficients in Magnets: J. R. Ashworth.—The Electric Conductivity of Nitric Acid: V. H. Veley, F.R.S., and J. J. Manley.—On the Calculation of the Co-efficient of Mutual Induction of a Circle and a Coaxial Helix, and of the Electromagnetic Force between a Helix and a Coaxial Circular Cylindrical Sheet: Prof. J. V. Jones, F.R.S.—On the Refractivities of Air, Nitrogen, Argon, Hydrogen, and Helium: Prof. W. Ramsay, F.R.S., and M. W. Travers.

MATHEMATICAL SOCIETY, at 8.—The Construction of the Straight Line joining Two Given Points: Prof. W. Burnside, F.R.S.—A Theorem concerning the Special Systems of Point Groups on a Particular Type of Base Curve: Miss F. Hardcastle.—A General Type of Vortex Motion; R. Hargreaves.—Note on a Property of Pfaffians: H. F. Baker.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting

FRIDAY, DECEMBER 10.

PHYSICAL SOCIETY, at 5.—An Exhibition of an Apparatus for Self-acting Temperature Compensation of a Standard Cell: Albert Campbell.—On Lord Kelvin's Absolute Method of Graduating Thermometers: Rose Innes.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Occultation of Ceres by the Moon on 1897 November 13, observed at the Hamburg Observatory: G. Rümker.—A Determination of the Latitude Variation and of the Constant of Aberration from Observations made at the Royal Observatory, Cape of Good Hope, 1892–94; W. H. Finlay.—The Binary Star *h* 5014: R. T. A. Innes.—Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1895, deduced from Photographs taken at the Royal Observatory, Greenwich, at Dehra Dûn (India) and in Mauritius.

MALACOLOGICAL SOCIETY, at 8.—A Description of a Supposed New Species of *Monodonta* (*Austrocochlea*) from Tablas Island: G. B. Sowerby.—On a New Species of *Amphidromus* from the Malay Archipelago (Alor Island): Hugh Fulton.—On a New Species and Probable New Sub-Genus of *Endodonta* from Ceylon, collected by O. Collett: Lieut.-Colonel H. H. Godwin-Austen, F.R.S.—Notes on a Second Collection of Marine Shells from the Andaman Islands, with Descriptions of New Forms: J. Cosmo Melvill and E. R. Sykes.—On a Small Collection of Marine Shells from New Zealand and Macquarie Island, with Descriptions of New Species: E. A. Smith.

SATURDAY, DECEMBER 11.

ESSEX FIELD CLUB (at Chingford), at 6.30.—Notes on the Conference of Delegates of Corresponding Societies of the British Association at Toronto: Prof. Meldola, F.R.S.—Two Essex Minerals: T. S. Dymond and F. W. Maryon.

SUNDAY, DECEMBER 12.

SUNDAY LECTURE SOCIETY, at 4.—Colour: Dr. C. W. Kimmins.

MONDAY, DECEMBER 13.

SOCIETY OF ARTS, at 8.—Gutta-Percha: Dr. Eugene F. A. Obach.

IMPERIAL INSTITUTE, at 8.30.—Canada's Metals: Prof. W. C. Roberts-Austen, C.B., F.R.S.

TUESDAY, DECEMBER 14.

ZOOLOGICAL SOCIETY, at 8.30.—On the *Lepidosiren paradoxa* from the Amazon: Dr. E. A. Goeldi.—On a Small Collection of Lepidoptera made by Mr. F. Gillett in Somaliland: Dr. A. G. Butler.—On the Mammals obtained by Mr. A. Whyte in N. Nyasaland, and presented to the British Museum by Sir H. H. Johnston, K.C.B.; being a Fifth Contribution to the Mammalogy of Nyasaland: Oldfield Thomas.—On a New Genus and Species of *Acaridea*: Rev. O. Pickard Cambridge, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Great Land-Slides on the Canadian Pacific Railway in British Columbia: Robt. B. Stanton.

ROYAL STATISTICAL SOCIETY, at 5.30

ROYAL PHOTOGRAPHIC SOCIETY (Society of Arts, John Street, Adelphi), at 8.—Colour Photography: Prof. Gabriel Lippmann.

WEDNESDAY, DECEMBER 15.

SOCIETY OF ARTS, at 8.—The Purification of Sewage by Bacteria: Dr. Samuel Rideal.

GEOLOGICAL SOCIETY, at 8.—On the Pyromerides of Boulay Bay, Jersey: John Parkinson.—The Exploration of the Ty Newydd Cave, Ffynnon Beuno, North Wales: Rev. G. C. H. Pollen.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Daily Values of Non-Instrumental Meteorological Phenomena in London, 1763–1896: R. C. Mossman.—The Rainfall of Seathwaite, Borrowdale, Cumberland: William Marriott.

CHEMICAL SOCIETY (Extra Meeting), at 8.30.—Kekulé Memorial Lecture: Prof. F. R. Japp, F.R.S.

ROYAL MICROSCOPICAL SOCIETY, at 8.—A New Form of Photomicrographic Camera and Condensing System: E. B. Stringer.

THURSDAY, DECEMBER 16.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—On the Affinities of the Madreporarian Genus Alveopora: H. M Bernard.—On West Indian Characeæ collected by T. B. Blow: H. and J. Groves.

CHEMICAL SOCIETY, at 8.—Stereo-Chemistry of Unsaturated Compounds. Part I. Esterification of Substituted Acrylic Acids: Dr. J. J. Sudborough and Lorenzo Lloyd.—Formation and Hydrolysis of Esters: Dr. J. J. Sudborough and M. E. Feilmann.—A New Method of Determining Freezing Points of very Dilute Solutions: Dr. M. Wilderman.

FRIDAY, DECEMBER 17.

INSTITUTION OF ELECTRICAL ENGINEERS (Chemical Society's Rooms), at 8.—Accumulator Traction on Rails and Ordinary Roads: L. Epstein.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Elastic Properties of Steel Wire: Archer D. Keigwin.—The Elasticity of Portland Cement: W. L. Brown.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—By Roadside and River: H. M. Briggs (Stock).—Catalogue of the Books in the Library of the Indian Museum, Supplement 2 (Calcutta).—Memoirs of the Geological Survey, Scotland: The Geology of Cowal: W. Gunn, C. T. Clough, and J. B. Hill (Edinburgh, Neill).—Stirpiculture: Dr. M. L. Holbrook (Fowler).—Studies in Psychical Research: F. Podmore (Paul).—Student's Guide to Submarine Cable Testing: H. K. C. Fisher and J. C. H. Darby (*Electrician* Company).—The Book of the Dead: Dr. E. A. W. Budge, 3 Vols. (Paul).—The Rod in India: H. S. Thomas, 3rd edition (Thacker).—Wild Life in Southern Seas: L. Becke (Unwin).—Famous Problems of Elementary Geometry: Profs. Beman and Smith (Boston, Ginn).—A Text-Book of Special Pathological Anatomy; Prof. E. Ziegler, translated and edited by Drs. D. MacAlister and H. W. Cattell, Sections ix.–xv. (Macmillan).—The Lepidoptera of the British Islands: C. G. Barrett, Vol. 4 (Reeve).—Philip's Revolving Planisphere and Perpetual Calendar (Philip).—Le Végétaux et les Milieux Cosmiques. J. Costantin (Paris, Alcan).

PAMPHLETS.—Radiography in Marine Zoology: Dr. R. N. Wolfenden (Rebman).—Untersuchung über die Bahn des Cometen 1822 IV.: Dr. A. Stichtenoth (Leipzig, Engelmann).

SERIALS.—Contemporary Review, December (Isbister).—Bulletin of the American Mathematical Society, November (New York, Macmillan).—Knowledge, December (Holborn).—National Review, December (Arnold).—Proceedings of the Liverpool Geological Society, Session Thirty-eight (Liverpool).—Geological Magazine, December (Dulau).—Fortnightly Review, December (Chapman).—An Illustrated Manual of British Birds: H. Saunders, 2nd edition, Part 2 (Gurney).—Physical Review, October (Macmillan).—Archives of the Roentgen Ray, November (Rebman).—Zeitschrift für Physikalische Chemie, xxiv. Band, 3 Heft (Leipzig, Engelmann). L'Anthropologie, Tome viii. No. 5 (Paris, Masson).—Gazzetta Chimica Italiana, 1897, fasc. v. (Roma).—Revue de l'Université de Bruxelles December (Bruxelles).

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THURSDAY, DECEMBER 16, 1897.

MENDELÉEFF'S PRINCIPLES OF CHEMISTRY.

The Principles of Chemistry. By D. Mendeléeff. Translated from the Russian (sixth edition) by George Kamensky, A.R.S.M. Edited by T. A. Lawson, B.Sc., Ph.D. Two vols. Pp. xviii + 621 and 518. (London: Longmans, Green, and Co., 1897.)

AN English translation of the earlier (fifth) edition of this remarkable book was prepared by Mr. Kamensky, and edited by Mr. A. J. Greenaway, in 1891. It is therefore familiar to the English chemical world; and that a second edition of the English version should be called for in a comparatively short time, is a proof that the views of the author have a fascination which secures for the book a wide circle of readers. The author speaks of it modestly "as an elementary text-book of chemistry"; but it is probable that the previous edition has been exhausted less by a demand on the part of beginners in the subject, for whom, to say truly it is little adapted, than as a consequence of the interest which has been excited among advanced students and professed chemists by the exposition of the doctrine embodied in the so-called "Periodic Law," which is the principal feature of the work. Enough has already been said in the pages of NATURE (see vol. xlv. p. 529) concerning the characteristics of the book itself—the extraordinary development of the foot-notes, which often expand to such dimensions as almost to drive the text out of the page, and which in many cases contain far more interesting matter; the strange inequality in the materials collected, many processes, especially those connected with manufactures, being quite antiquated; and others which need not be recalled. The confusion of proper names, owing to errors of spelling, is not so conspicuous as in the former editions, though one ludicrous substitution occurs in the chapter on spectrum analysis, where Huggins is three times over transformed into Huyghens! Such defects, however, do very little to impair the real value of the book, or obscure the genius of the author. Turning from the attitude of the literary critic to that of the scientific inquirer, it is much more profitable to see what such a chemist as Mendeléeff has to say about special questions of fundamental or primary importance.

In chemistry the word element is in constant use in the sense originally taught by Boyle, that is, signifying something which has up to the present remained undecompounded. At the present day the majority of chemists have probably settled down to the belief that our seventy or eighty "elements" represent limiting material, and that, so far as terrestrial affairs are concerned, so they will always remain. Others—probably however, a minority—conceive that relations among their atomic weights hint that they may be compounded of finer matter united in various ways, and though they may not expect to rupture the bond which unites the subatomic constituents together by any laboratory process, yet they see in the spectral phenomena of the stars evidence that under other conditions this rupture may actually be accomplished. Mendeléeff seems to believe in the permanence of the terrestrial elements, for not only in the two foot-notes on p. 20, vol. i., but in a long digression upon the subject of Prout's hypothesis (p. 439-441, vol. ii.), he emphatically rejects the idea that the atomic weights of other elements have any definite numerical relation to that of hydrogen, and he points out that attempts at transmutation of one element into another have been hitherto fruitless. "All such ideas and hopes," he says, "must now, thanks more especially to Stas, be placed in a region void of any experimental support whatever, and therefore not subject to the discipline of the positive data of science." Now and again, even at the present day, there is a recrudescence of alchemistic pretensions, but it may be noticed that the discovery for which a claim is put forward always relates to the transmutation of a base metal into silver or silver into gold. If any one suggested that he had succeeded, for example, in extracting lead from thallium, he would be laughed at for his pains, but if he boldly asserts that by a long and secret process he has succeeded in making gold out of silver, he generally finds a few people at least ready to take him seriously.

Chemical affinity is another expression still freely used, though with widely different meanings by different chemists; and here again a definite expression of the author's views is fortunately to be found in the pages of his book. He says (p. 27):

"For a long time, and especially during the first half of this century, chemical attraction and chemical forces were identified with electrical forces. There is certainly an intimate relation between them, for electricity is evolved in chemical reactions, and has also a powerful influence on chemical processes—for instance, compounds are decomposed by the action of an electric current. And the exactly similar relation which exists between chemical phenomena and the phenomena of heat (heat being developed by chemical phenomena, and heat being able to decompose compounds) only proves the unity of the forces of nature, the capability of one force to produce and to be transformed into others. For this reason the identification of chemical force with electricity will not bear experimental proof."

He then goes on in a characteristic foot-note to refer to the facts of substitution or "metalepsy," in which hydrogen, a "positive" element, may be exchanged for chlorine, a "negative" element, without altering the chief chemical characters of the compounds in which the exchange occurs. On a later page, also in a foot-note the author gives an account of the electro-chemical theories of Davy and Berzelius, and their relation to successive hypotheses of the constitution of salts; and here again he seems to reject all modifications of Berzelius' polar doctrine. It must be admitted, however, that the book is not strong in this direction. After much research we have not succeeded in finding a definite statement of such important facts as are embodied in Faraday's laws of electrolysis, the nearest approach to it being found on p. 581, but followed by an apologetic foot-note in which it is stated that the plan and dimensions of the book prevent the author from "entering upon this province of knowledge." This is to be regretted, considering the importance to the chemical student of a good acquaintance with the facts, methods

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and hypotheses of the now largely-developed province of electro-chemistry.

The preface of the new edition contains a special reference to the author's views concerning solutions—a subject for which he expresses great personal predilection, and to the experimental investigation of which he has devoted some time and labour. A paper by Mendeléeff relating to solutions of alcohol in water was communicated to the Chemical Society of London in 1887. He now states that we have not yet "the right to consider even the most elementary questions respecting solutions as solved." "My own view is that a solution is a homogeneous liquid system of unstable dissociating compounds of the solvent with the substance dissolved." In a foot-note, beginning p. 64, he explains the gas theory as applied to dilute solutions, and expresses the view that the physical and chemical aspects of the question, referring respectively to dilute and strong solutions, must be reconciled. The passage is too long for quotation; but supporters of the so-called hydrate theory may still count the great Russian chemist as on their side, at any rate so far as strong solutions are concerned.

There are, of course, many other subjects which the reader of the book will pursue with much interest, in view of the eminence of the author and the originality with which they are treated; but none of these will equal in attractiveness the subject of the grouping of the elements and the development of the periodic law. It is interesting to remember that, as the author tells us in the preface (p. xii), it was while engaged in writing the first edition of the book in 1869 that he first perceived the scheme and the application of the periodic law in its entirety. But it is only at the opening of the second volume that we come to the exposition of the principles which guided him in the grouping of the elements. This is accompanied by a foot-note which contains a historical *résumé* of the course of events which led ultimately to the recognition of these important principles by all chemists. And here we find a passage (*note* 13, p. 26) which sets forth clearly the depth and solidity of Mendeléeff's conception of the periodic "law," and the superiority of his claim to be regarded as the discoverer of the relation of properties to atomic weight among the elements. Having become convinced that the atomic weights and properties of the elements were mutually related in a certain manner, the Russian chemist did not hesitate to alter accepted atomic weights when required to fall in with the scheme, and to predict the properties of then undiscovered elements; while "neither De Chancourtois, to whom the French ascribe the discovery of the periodic law, nor Newlands, who is put forward by the English, nor L. Meyer, who is now cited by many as its founder, ventured to" do anything of the sort.

As such fortunate and valuable consequences have happily followed the study of the atomic weights by Mendeléeff, it is perhaps hypercritical to complain of his use of the term "law" in the vulgar ambiguous sense.

What after all is a "law of nature"? Is it not a compendium or summary of a series of observed agreements? and the statement so often used by Mendeléeff, that "the laws of nature admit of no exception," by no means proves that exceptions to any and every recognised law of nature may not hereafter be discovered. As such a statement now stands, it merely implies that in most cases the induction is at present incomplete. The question now comes, whether the periodic law itself is a "law of nature"? This is a question which must be troubling very much the discoverer of the law at the present time, now that the individuality of argon and, though less certainly, that of helium have been established. The subject is dealt with in Appendix iii. at the end of the second volume, written by Prof. Mendeléeff in February 1895, and here he clings to the idea that argon is a polymeride of nitrogen, or N_3.

This hypothesis, however, cannot be maintained. All that is known of argon shows that it is a gas having a density lower than 20 (H = 1), and hence that its molecular weight is less than 40, while that of N_3 would be 42. Argon and helium can at present be regarded only as a kind of chemical monsters brought unexpected and unwelcome, like the cuckoo, into the previously happy family of the elements where no place is provided for them. What, then, becomes of the "law of nature" if these two substances are admitted to be exceptions to the law as it now stands? and yet that they are exceptions is the conclusion which seems inevitable. W. A. T.

THE NATURAL HISTORY OF THE ANCIENT WORLD.

Les Choses Naturelles dans Homère. Par le Dr. A. Kums. Pp. 194. (Antwerp: Buschmann. Paris: Alcan, 1897.)

Gleanings from the Natural History of the Ancients. By the Rev. M. G. Watkins, M.A. Pp. xiii + 258. (London: Elliot Stock, 1896.)

The Works of Xenophon. Translated by H. G. Dakyns, M.A. Vol. iii. part ii. Pp. lxx + 130. (London: Macmillan and Co., Ltd., 1897.)

Aristotle on Youth and Old Age, Life and Death and Respiration. Translated, with Introduction and Notes, by W. Ogle, M.A., M.D. Pp. 135. (London: Longmans and Co., 1897.)

THE consideration of the animal world is usually approached from one or other of three points of view. We may be interested in the structure—the morphology and physiology—of animals, and in their place in nature: this is the biological interest. Or we may be especially interested in their habits and doings, and every one has at least observed something of the characters and ways of more than one species of animal. Or we may regard animals as objects of the chase or material for human food. The first of these interests is purely scientific; it must exclude hearsay and fancy; it must be based on the most careful observation and examination with the aid of all the appliances that contemporary art and manufacture can furnish; and it must admit nothing that is unverifiable or supported by doubtful authority. On the other hand, the study of the habits and characters of animals can seldom confine itself to lines so rigidly laid down as these; not only is it extremely difficult for the most scientific investigators to interpret or even to record the actions of the lower creatures without a certain, often unconscious, anthropomorphism or reading-in of motives into them; but we are also confronted by a mass of current beliefs and superstitions, and imperfectly authenticated tales which, in view of their frequent repetition and the widespread evidence accorded

to them, it is impossible to dismiss unconsidered, improbable though they may seem at first. Such legends can never be wholly banished from view until we have accounted for their coming into being at all; and the naturalist is thus frequently led into the domain of folklore and the study of primitive religious ideas, which from totemistic stages onwards have always in some way or other touched upon the connection of the human and animal worlds. The attitude of the huntsman is different from both those just considered: he makes a very minute study of some of the habits of a few animals, mainly with a view to making himself master of them in a manner gratifying to the sporting instinct.

In the volumes before us all these interests are represented. They all deal with the attitude of the Greeks—in part also of the Romans—to animal nature. Until the time of Aristotle scientific study can hardly be said to have existed, though in him, so far at least as method is concerned, it appears suddenly in almost as systematic a form as any science can boast of at the present day. But hunting and the observation of the ways of animals seem to have been habitual to the Greeks. No one can have failed to notice the unerring accuracy with which Homer, in a few graphic strokes, brings before his readers some familiar scene from nature—the lion and his prey, the jackals surrounding the stag, the tettix, "which in the thickets, sitting on a tree, sendeth forth its thin clear voice," and very many others. Again, the hunting of the boar and of the stag, with all their accompaniments, Homer knew well, and in the works of Dr. Kums and Mr. Watkins all these and kindred topics are treated in some detail. Dr. Kums confines himself to Homer, and it is to students of Homer that his book will be especially interesting. It is an enumeration under classified headings of all that Homer says in different passages about the various departments of nature and human nature, and is a very accurate, complete and well arranged compilation. But it is no disparagement of the book to say that, for the most part, it is not of great general scientific importance. External nature only enters into the poems of Homer as it were by accident, in similes which illustrate human action, or in descriptions of events affecting human agents; and the interest which he arouses is artistic rather than scientific: we are chiefly struck with the perfect description of what the poet saw, with the clearness and truth to life of his pictures. Mr. Watkins, in his "Gleanings," allows himself to range over the whole field of classical literature, and under the title of the "Ancients" he includes not only the Greeks and Romans, but the early Teutonic and Celtic races, and especially our own forefathers; indeed, he deals with much literature that cannot be called "ancient" in the ordinary sense of the word at all, even English literature down to about the sixteenth century. His work is a collection of points which have interested him in the course of his unusually wide reading, in regard to the observation and appreciation of the animal world in periods when science had not become scientific; and we find, not of course a serious or systematic contribution to science or to the history of science, but a delightful mosaic of quotations, anecdotes and folk-lore, very artistically put together, and compared with modern views as expressed in passages from Darwin and other writers. The occasional antiqueness of the author's language, and even the use of the long ſ in the type, which unsympathetic critics would no doubt condemn as affectation, are in keeping with a certain *naïveté* and gracefulness of manner, which add greatly to the pleasure given by the large amount of entertaining information which the book contains. We should not expect in such a book, and we do not find, a complete exposition of the Aristotelian "Systema Naturae"—the only great contribution of the ancient world to natural history and biology; but the author appreciates very fairly indeed the merits of Aristotle and other ancient writers from the naturalist's point of view. Aristotle he recognises as having "sifted much of the popular knowledge, as is his wont"; though even Aristotle is gently censured as uncritical in comparison with modern writers. (To this we shall return.) Pliny, on the other hand,

"though he lived so much later, was an eager listener to all old women's tales. . . . The vastness of his own compilations, and his perpetual industry in noting any circumstances of interest connected with Natural History, smothered his judgment. He had neither time to sift facts nor to weigh the authority to be attached to the statements of other authors; and these defects leave his great 'Natural History' a *rudis indigestaque moles* which compares unfavourably with the more exact and painstaking work of Aristotle."

It is a pity that Virgil is usually quoted in Dryden's translation (of whose defects Mr. Watkins is himself not unaware); for this rendering hopelessly obscures the quite unique power possessed by Virgil of calling up—often by a single word or line—inimitable pictures of external nature, whether scenery or animal life.

The book contains chapters on dogs, cats, owls, pygmies, elephants, horses, gardens, roses, wolves, fish, oysters and pearls. In a chapter on mythical animals there is a neat discrimination of the causes and characteristics of the animal folk-lore of several early peoples. Homeric and Virgilian natural history receive separate treatment; and a specially interesting portion of the work deals with the Romans as introducers into Britain and acclimatisers of a number of well-known animals and plants. We should like to see a fuller account of the influence on our fauna and flora of the periods marked respectively by the Roman occupation, the influx of monks from the continent, and the return of the Crusaders from the East, to all of which our author believes we can trace the introduction of many species. With the mention of a chapter on "Hunting among the Ancients," we may pass to Mr. Dakyns' translation of the *Cynegeticus* of Xenophon. This is hardly the place for a long notice of this work. Suffice it to say that it contains the same kind of matter as we should expect to find in a volume of the Badminton Library dealing with the same subjects—the hunting and tracking of hares with dogs and nets, and the chase and trapping of deer. The habits of the hare, the training, breeding points and management of dogs, and the functions of the keeper, are very fully treated; incidentally, too, precepts of sporting etiquette are introduced, *e.g.* the following:

"Here it should be added that the sportsman, who finds himself on cultivated lands should rigidly keep his hands off the fruits of the season, and leave springs and rivers alone. To meddle with them is ugly and base"

(Mr. Dakyns is responsible for this rather odd translation), "not to speak of the bad example of carelessness to the beholder."

The work is a marvellous display of close and intelligent observation by an enthusiastic sportsman, and will be full of interest to persons of similar taste in the present day. Of course it contains a good deal of "keepers' superstition," very similar to the fancies of the modern keeper, but this, perhaps, adds to the interest; and many more or less brilliant suggestions are made in explanation of facts which seemed to be in need of it. Mr. Dakyns' translation is spirited and, on the whole (to judge from passages chosen at random), accurate; and any sportsman into whose hand the book falls will feel grateful to him for rendering accessible the work of, perhaps, the acutest observer of outdoor life in antiquity.

In turning to Dr. Ogle's translation of some of the minor treatises of Aristotle, we enter the domain of science proper. The translator's name is sufficient guarantee of the excellence alike of introduction, translation, and notes: the work is quite up to the standard of the "Parts of Animals" by the same editor. Shortly, the doctrine contained in the treatises translated rests on the belief that life depends upon heat: the source of this heat was the heart, in which heat was continually being generated by the concoction of food received from the stomach and passed into the heart; and the heat thus generated supplied the place of that which was continually being given off by the body. But life might be destroyed by excess no less than by defect of heat; this excess was provided against by respiration, which cooled the violence of the "fire" in the heart, which always tended to become excessive: in the case of pulmonate animals, the air in the lungs was the means of refrigeration; in the case of branchiates, the water playing upon the gills. Natural death (as distinct from death by disease or violence) was due to the gradual exhaustion of vital heat—an idea at least as clearly defined as the "vital force" of many modern physiologists. The causes of longevity (in these and other treatises) are somewhat vaguely stated, but the correlation of longevity with such characters as large size, high organisation and length of the period of gestation, was observed by Aristotle. These points are, of course, worked out in much greater detail, and the exposition of them by Aristotle cannot here be reproduced at length. The first impression of an ordinary reader will probably be that views so absurd and obsolete are not worth consideration. But on further attention, we find that obsolete though these views may be, yet they were the first step towards a really scientific physiology. The physiology of Plato and Democritus was pure guesswork, or at least only guided by preconceived theories not falling within the range of physiology. It was Aristotle who first saw

"that the study of function must be preceded by the study of structure, or in other words, that physiology must be based upon anatomy. . . . By insisting on the absolute necessity of anatomical observation, he carried biology at one step from the world of dreams into the world of realities; he set the science on a substantial basis, and may indeed be said to have been its founder, for the same imaginings of his predecessors can hardly be dignified with the name of science."

And, to quote a later passage of Dr. Ogle's introduction:

"If we perform the difficult task of excluding from our minds all ideas and facts since acquired, we shall find ourselves constrained to admit that in Aristotle's days no better hypothesis could have been devised with which to colligate the facts or supposed facts then available."

And when we consider that such ideas and facts include among others those of chemical combination, the circulation of the blood and the existence of nerves, we shall be surprised to find the difference between the Aristotelian and the modern theories so slight as it is. In fact, as Dr. Ogle shows both in the introduction and notes, a very slight alteration of terminology is often all that is required to convert Aristotle's statements into propositions which would still be accepted as true; and even in their crude form, many of his doctrines (or something very like them) were held by the most advanced scientific men of recent centuries, Harvey himself among others. It is further remarkable that Aristotle should, with the extremely inadequate instruments and appliances at his command, have produced results so accurate in the region of anatomy and embryology: his account, *e.g.* of the lung, is a model of careful description so far as it goes, and the work before us will provide many other instances. Aristotle, of course, had his defects, and his editor points these out frankly: he occasionally (though far less than any other ancient author) took mere hearsay for fact; and he was scarcely alive to the importance of experiment. But he had a definite method of investigation; his conclusions were always based on recorded observations of himself and others; the advance he made was almost incredibly great for one man; and the lines he laid down have been (though unconsciously) followed and developed by all great physiologists ever since. To quote Dr. Ogle once more:

"There are minds to which the mistakes and shortcomings of great men apparently present greater attraction than their achievements. To them Bacon is but a man who believed in the spontaneous generation of mistletoe; Cuvier, an upholder of the fixity of species; Kepler, one who thought that the huge volcanoes in the moon were artificial structures built by its inhabitants; Descartes, an asserter of the immediate transmission of light; and Newton himself an advocate of the emission theory. To such persons Aristotle's anatomical statements will doubtless supply much desirable pabulum. But those more genial critics who prefer to dwell upon what a man has done well rather than what he has left undone or done amiss . . . will admit that never has a science been started on its career by its originator with so large an equipment of facts and ideas as that with which Comparative Anatomy left the hands of Aristotle."

THE MEASUREMENT OF RAPIDLY VARYING ELECTRIC PRESSURE.

The Capillary Electrometer: its Theory and Practice. Part i. By G. J. Burch, M.A. Pp. 54. Reprinted from the *Electrician.* (London: G. Tucker.)

MUCH of the present knowledge concerning the capillary electrometer is due to the author of this little book. The instrument was invented in 1875 by Prof. Lippmann, but for twenty years it was hardly used

by any people except physiologists, and even by them only in a doubtful sort of way, for they thought that its indication gave merely the period and direction of a sudden change of P.D., and they feared that the magnitude of the variation could not be deduced from the excursion of the meniscus formed at the junction of the threads of mercury and dilute sulphuric acid.

It may be well to mention that we use the letters "P.D.," not merely because they appear to us to be a convenient abbreviation for "potential-difference," but because Mr. Burch, by employing them throughout his book, shows that he has the same opinion.

The book commences with a description of the best methods of constructing a capillary electrometer to which the author's experience has led him, and the reader is warned regarding the faults which he is likely to meet with in the practical use of the instrument, and instructed how to overcome those that can be remedied without making a new instrument.

The first two points that Mr. Burch determined to ascertain experimentally, when he began his work on the capillary electrometer in 1886, were: (1) Does any current pass through the instrument after the meniscus in the capillary tube has reached its stable position for the particular P.D. applied; and (2) does any leakage take place through the instrument if the applied P.D. be withdrawn after the meniscus has been deflected? To each of these questions experiment gave a negative answer, and he was, therefore, led to the conclusion that, although the circuit of a capillary electrometer is composed entirely of conducting substances, and, although there is no visible insulating dielectric, the instrument transmits no current with a P.D. of less than 0·5 volt, but merely receives and maintains a charge as if it were a well-insulated condenser.

The capacity of different capillary electrometers was found by the author to vary between 0·1 and 30 microfarads, but instruments having a capacity of between 0·5 and 2 microfarads gave the best results. When the capacity is unchanged on moving the mercury thread through a considerable portion of the capillary tube the electrometer is found to be equally sensitive throughout that part of the tube.

The author concludes that this instrument is essentially adapted to the poor man, since its cost, including that of the microscope, is less than that of any other electrometer of the same sensibility. It also has the advantage of responding with extreme rapidity to every change of potential.

Various methods are described in detail for obtaining records on photographic plates, having a rapid linear or circular motion, and the author shows how the instantaneous value of a rapidly varying P.D. can be deduced at any point of the photographic curve from the fact, which he proves, viz. that the value of the applied P.D. is measured at any moment by the instantaneous distance of the meniscus from the zero position *plus* the rate of motion of the meniscus at that moment. And in the case of the photographic plate moving circularly, he points out that the second term, depending on the instantaneous value of the velocity of the meniscus, is given by the length of the subnormal to the curve at the particular point.

The book concludes with some interesting examples of curves obtained with telephones, direct and alternate current dynamos, &c., from which the value of the capillary electrometer may be clearly seen.

The reasoning in some parts of the book is not very clear; and, while the figures of the parts of the apparatus itself are in many cases bold and well executed, those illustrating the geometrical reasoning, and the results obtained with the photographic plates, are not as intelligible as one would like. We hope to see Part ii. of this book at an early date; and, for the benefit of those who do not resemble the author in being masters in the use and the theory of the capillary electrometer, we trust that he will not hesitate to sacrifice compression to clearness.

W. E. A.

OUR BOOK SHELF.

A Handbook to the Geology of Cambridgeshire, for the Use of Students. By F. R. Cowper Reed, M.A., F.G.S. 8vo. Pp. x2 + 76. (Cambridge: at the University Press, 1897.)

THE geology of Cambridgeshire possesses a special interest for many students. From Cambridge itself there have sprung a greater number of expert British geologists than from any other seat of learning in this country. Though founded by John Woodward, the school was created by Sedgwick; and it has been carried on with signal success by Prof. Hughes. This success, as the present Professor has cordially acknowledged, is partly due to the band of brilliant assistants he has gathered around him. Thus special instruction is given in all branches of geology, and the author of the present work has during recent years rendered aid in the department of stratigraphical palæontology. To a casual visitor the scenery and geology of Cambridgeshire may offer but few attractions, for the country is mostly low-lying, and there is much clay-land and fen. Oxford affords a greater variety of scenery and a more attractive series of fossiliferous formations. Nevertheless, there is much in Cambridgeshire geology to arouse interest when once an enthusiasm for the science has been kindled, and there was need of a concise handbook which should clearly describe and explain the leading facts that have been made known. The excellent "Sketch" by Prof. Bonney dates back to 1875, and the more detailed geological survey memoir on the neighbourhood of Cambridge, by Penning and Jukes-Browne, was issued in 1881. The present work is a model of what a county geology should be. The zones in the Jurassic and Cretaceous rocks, the phosphatic nodules in Lower Greensand and Chalk, the glacial deposits, valley-drifts, and recent accumulations, are all duly described and accompanied by full records of the fossils. If we find fault at all, it is that the author has entered at too great a length into certain contrary views regarding the formation of the Chalky Boulder Clay, for the extraordinary "diluvial theory," as he himself admits, "finds few supporters at the present time." Even the view of S. V. Wood, jun. (noted on p. 168), was modified in that geologist's latest publication.

Our author rightly wanders a little out of the county to give some account of the Red Chalk of Hunstanton, because it is so frequently visited by Cambridge students.

Brief chapters are given on the antiquity of man and on water supply. With regard to the latter subject, we would question the statement (quoted by the author) that "if the Oxford Clay was pierced we might reasonably expect an abundant supply of water." The outcrop of Lower Oolites is some distance away, while at St.

Neots the water that was obtained at a depth below the surface was saline in character. A full and useful bibliography completes this excellent and well-arranged work. H. B. W.

Wild Traits in Tame Animals. By Louis Robinson, M.D. Pp. vii + 329. Illustrated. (Edinburgh and London: Blackwood and Sons, 1897.)

Dr. Robinson points out in his introduction that the amateur naturalist is a valuable and necessary member of the scientific community. He detects a tendency on the part of the professional naturalist to warn the amateur off the ground. Whether any such mischievous claim of proprietorship is actually set up is not clear to us; the naturalist who pursues his hobby for recreation only is, according to our own experience, welcomed by everybody, if only he is a good fellow, who will bring in his own contributions, great or small, to the general stock, and not spread false information. Dr. Robinson's animated defence of the amateur naturalist may therefore be gladly allowed to prevail; we are only surprised to learn that any defence is needed.

Our author holds that no one in these days can study animals with due profit who is not a Darwinian; he would have his amateur naturalist "an evolutionist down to the tips of his toes." We are not so heartily on his side here. There is risk of spoiling a quick and trustworthy observer by saturating his mind with theories. If natural facts are reported to us, they do not gain in credibility by being expressed in evolutionary phrase. It is good that every naturalist should think upon his facts, but let him think independently, not as an evolutionist, nor as a partisan of any school whatever.

We like the papers which form the bulk of the book much better than the introduction. Dr. Robinson discourses upon dogs, horses, donkeys, cattle, sheep, goats, pigs, cats and poultry. The first two of these seem to us the most interesting, but all possess good points. The author gives us a lively object-lesson upon each animal, trying to explain its structure and habits by the mode of life of its wild progenitors. Very many of his interpretations have been anticipated; that is to be expected; but everything is cast into a new and engaging form; it reads like personal experiences illuminated by the writer's own reflections. No reader who thinks for himself will accept all Dr. Robinson's conclusions, but he will find his interest in the subject heightened, and his sagacity exercised by these amusing dissertations. L. C. M.

The Psychology of the Emotions. By Th. Ribot. Pp. xix + 455. (London: Walter Scott, Ltd., 1897.)

In this book Prof. Ribot gives a very complete account of his subject. In the first part he deals with pleasure and pain and the general nature of emotion. He advocates a theory of emotion which he terms "physiological." Feeling is regarded as a primary aspect of mental life, closely connected with biological conditions; and the author seems to think that it is hopeless in this region of psychology, at any rate, to depend wholly on purely psychological methods, the subject only becoming intelligible by going beyond consciousness and treating it in its physiological relations. As part of this general theory Prof. Ribot adopts, with some qualification, the theory illustrated by James in the words, "we feel sorry because we cry, angry because we strike, afraid because we tremble." In the second part, dealing with the special forms of emotion, no attempt is made to give an elaborate classification; but the chief aspects of emotional life are described in the order in which they seem to have developed. In this part, and especially in the chapters on character and temperament, the author brings out the great value of pathology in the study of psychology.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Passive Condition of Resting Protoplasts.

The appearance in your last issue of a short paper recently communicated to the Royal Society by myself and Mr. F. Escombe, on the "Influence of very Low Temperatures on the Germinative Power of Seeds," affords me an opportunity of calling attention to two important papers which only became known to us after our own was in print. Both these communications materially strengthen the argument against the necessary existence in resting protoplasts of ordinary respiratory exchanges, or of any metabolic changes resulting in "intra-molecular respiration."

The first paper is by W. Kochs (*Biol. Centralbl.*, 10 (1890), 673), who has shown that dry seeds, placed for many months in the vacuum of a Geissler's tube, do not evolve an amount of carbon dioxide or nitrogen capable of detection by subsequent spectroscopic examination of the contents of the tube, a fact which certainly negatives the idea of any gaseous evolution by "intra-molecular respiration."

The other omission is one which is much less excusable, since it has reference to a very important letter communicated to your columns by Prof. Giglioli as recently as October 3, 1895.

In continuation of certain experiments, described in 1878, on the power of resistance of seeds of *Medicago sativa* to the action of certain gaseous and liquid chemical reagents, Prof. Giglioli re-examined the seeds which had been placed under these special conditions continuously for a period of more than *sixteen years*. He found that some of the seeds retained their vitality even when surrounded by atmospheres of nitrogen, chlorine, hydrogen, arseniuretted hydrogen, and nitric oxide; whilst immersion for sixteen years in strong alcohol, and in an alcoholic solution of mercuric chloride, still left a large number of seeds capable of subsequent germination.

That we have been anticipated in some of the conclusions of our paper, based on a totally different method of experiment, will be clearly seen from the following quotations from Prof. Giglioli's letter:—

"My experiments encourage, moreover, the suspicion that latent vitality may last indefinitely when sufficient care is taken to prevent all exchange with the surrounding medium." . . . "It is a common notion that life, or capacity for life, is always connected with continuous chemical and physical change. The very existence of living matter is supposed to imply change. There is now reason for believing that living matter may exist, in a completely passive state, without any chemical change whatever, and may therefore maintain its special properties for an indefinite time, as is the case with mineral and all lifeless matter. Chemical change in living matter means active life, the wear and tear of which necessarily leads to death. Latent life, when completely passive, in a chemical sense, ought to be life without death."

Prof. Giglioli concludes his letter with a reference to the possibility of an extra-terrestrial origin of life on the earth, through the medium of meteorites. Horace T. Brown.

52 Nevern Square, Kensington, December 13.

Discovery of a Large Supply of "Natural Gas" at Waldron, Sussex.

The discovery of this gas occurred accidentally while boring for water in the parish of Waldron, Sussex. The boring was commenced in the lower strata of the "Ashdown sand" (Hastings beds), and was continued to the depth of 377 feet, when the work was stopped. A strong smell of "gas" having been noticed, a light was applied to the top of the lining tube of the bore, and a flame immediately sprang up to the height of 15 or 16 feet, and burned with great fury until it was put out by means of damped cloths being thrown on to the top of the tube (Fig. 1).

It is not quite certain at what level the first release of the gas occurred; and the workmen say that they noticed the smell of it for nearly a month before the testing with a light occurred, during which time boring was carried on.

An iron cap has now been fixed on the top of the tube with a vent. allowing an escape of the gas to take place continuously (see Fig. 2). When lighted this jet flares out about the same size and colour as one of the "naphtha flarers" commonly

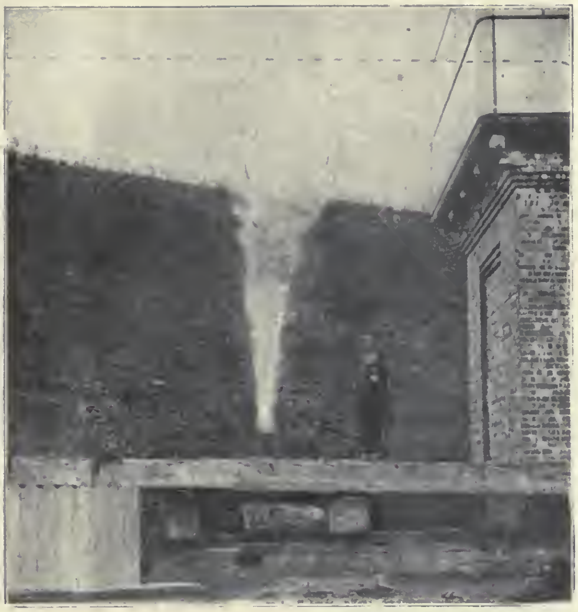

FIG. 1.—Flame of natural gas from bore-hole at Waldron, before the present cap was fixed on the tube. The broken line near the top shows the height of the flame through the six-inch bore-tube.

used for lighting at fairs and markets, viz. about 12-inch flame. This cap and vent have now already been fixed about fifteen months, and the gas from the vent can be lit at any time, and shows no sign of diminution

FIG. 2.—Bore-tube in well, with cap having a small vent fixed upon the top. The flame of natural gas is shown rising to the left.

I have taken samples of the gas, and submitted it to the county analyst for East Sussex (Mr. S. A. Woodhead), and he informs me, although he has not yet completed his analysis, that the gas is probably derived from petroleum. The presence of certain beds impregnated with petroleum underlying these Wealden beds in East Sussex, has been noticed before while making deep shafts and borings.

Many of the beds in the Purbeck strata (Brightling series) consist of dark leathery shales which emit a strong odour of petroleum, and small traces of it are also occasionally met with in the Gypsum quarries at Netherfield (Sussex). Beds of lignite, and a variety resembling "Cannel coal" (about 2 feet thick) have been met with near the surface in the parish of Waldron (Lower bed of Ashdown sand, Fairlight clays), and several bands of lignite were pierced by the boring at Waldron where the "gas" was found.

The gas is probably derived from these beds of lignite, and perhaps from the petroleum shales of the Purbeck beds; or possibly, but less probably, from the Kimeridge clay underlying these beds (Sub-Wealden boring), which contains a hard, light-coloured bed rich in petroleum.

In reading through the quarterly reports of Mr. Henry Willett, made during the progress of the Sub-Wealden boring (Netherfield, 1875), I find that strange oscillations had been noticed in the depth of the water in the bore-tube. These were attributed to the "accumulation and discharge of carbonic acid, and of inflammable gases derived probably from the petroleum-bearing strata beneath. The discharge of these gases was proved by the extinction of light at various depths, and by an *explosion* at another time."

The discovery of the gas has hitherto been kept a secret among a few. There appears to be at present an ample supply of gas for the lighting of a town if the necessary plant were erected in connection with the tube, and there also seems to be, so far as one can judge, a constant supply. How long it may continue is, of course, a matter of conjecture; but having already run to waste so long without any decrease in force, I think that the supply might be made use of with reasonable prospects of lengthy continuance.

This notice must be regarded as a preliminary one merely, as I am making experiments with the gas, and examining the cores of the boring with a view to ascertain the source of the supply.

CHARLES DAWSON.

Uckfield, Sussex.

THE ORIENTATION OF GREEK TEMPLES.[1]

IN giving an account of my second series of observations on the orientations of Greek temples, and the chronological deductions which may be made from them, it seems desirable to recapitulate as briefly as possible the main points which underlie the inquiry.

The subject was introduced to me about eight years ago by Sir Norman Lockyer, who had discovered that there was a very strong probability that in every case the axis of an Egyptian temple, or in other words its orientation, was aligned to that point of the local horizon where at the time of its foundation some conspicuous star rose or set, and that in the case of temples oriented within zodiacal limits, it was also so arranged that on the day of the principal feast of any particular temple, which always took place on a day when the sun at its rising would shine upon the altar or statue of the god, the star should be seen from the sanctuary, through the always narrow eastern opening, shortly before sunrise.

There is plenty of evidence from various sources that *heliacal* stars, as they are called; that is, stars when just visible at their rising before their light is overpowered by the rays of the rising sun, or setting whilst still distinguishable, were very much observed by the ancients. And the use of an heliacal star so observed in connection with temple worship was to give warning to the priests to enable them to be ready for the sacrifice or other function at the exact moment of sunrise. Roughly speaking, a bright heliacal star would in Greece give nearly an hour's warning of the sun's approach, though somewhat less in Egypt.

If in almost every case a connection, such as I have indicated, between the orientation of a temple and the

[1] Abstract of a paper read before the Royal Society, March 11, 1897. On the Orientation of certain Greek Temples, and the Dates of their Foundation, derived from Astronomical Considerations—being a supplement to a paper on the same subject published in the *Transactions* of the Royal Society in 1893—by F. C. Penrose, F.R.S

sunrise effect in the sanctuary, preceded by an heliacal star, can be established, it carries an amount of probability of the truth of the theory which it is very hard to gainsay.

To us the practical use of such theory is, that it gives the means of determining very approximately the date of the foundation of any temple, namely the time when the sunrise and the heliacal star were so connected.

As seen from a given point at its rising or setting, the amplitude of a star (that is, its bearing from true east or west) is subject, as time goes on, to a slow alteration resulting from the displacement of the star, in consequence of the celestial movement called the precession of the equinoxes, and this can be calculated with great precision so as to show the date at which it would have been visible as the forerunner of the sun from the sanctuary of a temple. There is architectural evidence in Egypt that attempts had been made to retain the use of such stars, and in two ways: one by a structural alteration in the eastern opening, so as still to allow of its being seen; and the other as evidenced by finding that a temple, architecturally of later date, but of the same cult, had been built alongside of an older temple which had lost the star which had at one time served as its morning clock.

Sir Norman Lockyer having been satisfied that the principles of temple building, as above mentioned, had prevailed in Egypt, and being led by a cursory examination of Greek examples to suspect that the same would be found to prevail in that country also, invited me to take up this inquiry with respect to Greek temples, which led to my making a preliminary communication to the Society of Antiquaries in 1891, and a more detailed report to the Royal Society in 1893, of which an abstract appeared in NATURE, May 11, of that year. The paper itself was published in the *Transactions* of the Royal Society (vol. 184, pp. 805 *et sqq.*) to which the supplement, already referred to, was published in vol. 190, pp. 43 *et sqq.* The first series contains more than thirty examples, the second nearly as many, and both collections entirely confirm the view of the matter already made highly probable from Egyptian sources. Indeed the second series, chiefly drawn from colonial Greece, is in one respect more satisfactory than the previous one.

The architectural remains of the greater number of the temples in Greece proper, comprised in the first list, do not accord with the early dates derived by calculation from their orientations; and it is necessary to assume that in the majority of cases a temple, of which we find the ruins, was built parallel to the lines of an earlier structure which had conformed to the orientation postulate, and the date arrived at is that of the first foundation on the site. Traces of such earlier foundation can, however, be actually found or inferred in a sufficiently large proportion of the whole to justify the assumption; but in more than half the cases they have either disappeared or not yet been found. In the colonial examples of the last series, however, quite two-thirds of the orientation dates are consistent with the architectural remains now standing, without need of any hypothesis respecting foundations as yet undiscovered.

All the temples I have met with in Magna Grecia or Sicily are what may be named solar temples; namely, those which admit of being lighted through an eastern door by the sun when rising in the line of the axis. Three of them, indeed, lie on the solstitial limits; of this I did not find any examples in Greece. The nature of the inquiry in a solar temple is of this kind, viz.: given the angle of orientation, and the apparent height of the eastern horizon, we calculate the declination which the sun would have required to illuminate the sanctuary at its rising (allowance being made for the variation of the obliquity of the ecliptic many years ago, an allowance which may require a small correction when an approximate date has been arrived at). From this the sun's right ascension is computed, giving generally two values—one vernal, the other autumnal. The next search is made for a suitable star. It must be remembered that in the case of a rising star the declination cannot differ much from that of the sun, or else it could not be seen through the same narrow opening, and to be serviceable as a warning star, it must precede in right ascension by a suitable interval; if too short the star could not be seen, if too long its warning would be inconveniently early. Thus the data for the preliminary search are: for declination, that already ascertained for the sun, and for right ascension, one hour less may be taken.

It would occupy too much space to enter into the details of the calculation which involves the change due to the movement of the star from *precession;* but if the result shows that a conspicuous star or constellation, either in the spring or autumn (and within the limits of possible archæology), occupied approximately the position required by the hypothesis, the discovery will justify a more exact computation. Should it, however, fail for a rising star, there still remains the search for a setting star which would fulfil the proper conditions. The search is conducted on analogous principles, but with difference in detail.

In more than fifty cases which I have tried by the four lines of investigation indicated above, I have succeeded in finding in each one solution, and one only. In two I have obtained an alternative possible star; the choice between the two requiring to be settled archæologically. In not one case of which I had full particulars have I failed to find an answer.

An objection has been made that, as there are so many stars in the heavens, some solution of the problem is inevitable, without there having originally been any intentional correspondence. The answer is not difficult.

Firstly, there are very few available stars. They must be of sufficient brightness; a third magnitude star is the very minimum, and could only be resorted to (unless in a close constellation like the Pleïades or Aquarius) if situated very much by itself, so as not to be mistaken for any other. They must also be near enough to the ecliptic to be seen through the narrow eastern opening. A list of fourteen single stars and two star groups exhausts the whole possible number. Moreover, they must be so placed in the firmament as to satisfy the condition required for warning stars. Again, in the two hundred trials made for the fifty temples, as mentioned above, would there (in the case of the assumed multitude of stars) have been one hundred and fifty misses to the fifty hits which were wanted; and if there had been no arrangement, and the orientations had been fortuitous, would the most ancient sites have always secured the oldest orientation dates, and those of which the recent foundation is historically known have taken their proper rank?

It is true that the sequence might have been acceptable, but not so the exactness of the dates. These must depend upon the correctness of certain assumptions with regard to the elements of the problem, especially as to the altitude of the star and the depression of the sun at the heliacal phase, if it may be so called.

From a good deal of attention which I paid to the visibility of stars in twilight I derived the following rules, from which all the calculations have been made, except in a very few cases where local circumstances required some modification. The rules are made for the case of rising stars. When setting in the morning twilight they may be seen nearer to actual sunrise; but it is probable that the same rule would have been applied, as the same time would have been required for warning, whether a rising or setting star was used. It may be observed that rising stars seem to have been the favourites, in proportion of about three to two.

In ordinary fair weather in Greece or in South Italy I

found that a first magnitude star can be seen at an altitude of 3° when the sun is 10° below the true horizon. A second magnitude should require an altitude of 3° 30′, with the sun depressed 11°; whilst a third magnitude star, of the use of which there are very few examples, would require a depression of 13°. A general confirmation of these elements may be drawn from Biot's "Recherches sur l'Année Vague des Égyptiens," in which he derives from Ptolemy that in Egypt a solar depression of 11° was considered proper for the observation of heliacal stars. This seems a very reasonable mean for the rules of solar depression applying to stars of different magnitudes as given above.

Following these rules, I obtained orientation dates for the temples I examined last year as below.

—	—	—	Orientation date	—	—
			B. C.		
	Athens	A small temple near Jupiter Olympius ...	780	September 23	Spica setting
	,, ...	The ancient Asclepieium	560	April 5 ...	α Arietis rising
Greece ...	Delphi	First foundation of Temple of Apollo ...	970	March 1 ...	β Lupi setting
	,, ...	Rebuilt so as to follow the star	630		,, ,,
	Argos	The ancient Heræum...	1830	October 24 ...	Antares rising
	Taranto	A Doric Temple	640	November 10	,, ,,
	Metapontum ...	Foundations of a temple near San Sansoni...	610	December 21	β Geminorum setting
Calabria ...	,, ...	Doric Temple	580	March 6 ...	γ Pegasi rising
	Near Cotrone ...	Temple of Juno Lacinia on Cape Colonna ...	1000	March 28 ...	α Arietis rising
	Near Gerace ...	Ionic Temple of the Locrians	610	December 21	β Geminorum rising
	,, ,, ...	Ditto rebuilt on same site	430	November 23	β Tauri setting
	Girgenti	Temple of (attributed to) Juno Lacinia ...	690	April 1 ...	α Arietis rising
	,, ...	,, ,, Hercules	470	March 20 ...	Spica setting
Sicily ...	,, ...	,, ,, Concord	450	,, ...	,, ,,
	,, ...	,, ,, Jupiter	430	April 14 ...	α Arietis rising
	,, ...	,, ,, Castor	400	September 13	Spica setting
	Segeste	Temple (perhaps) of Jupiter	550	April 5 ...	α Arietis rising
	Selinus	The Archaic Temple called Temple C ...	795	September 30	α Arietis setting
	,, ...	Temple D (adjoining and following the star)	610	October 4 ...	,, ,,
	,, ...	Temple A	550	March 5 ...	γ Pegasi rising
	Syracuse	Temple forming part of Duomo	815	September 20	Spica rising
	,, ...	,, of Jupiter	610	October 3 ...	α Arietis setting
	,, ...	,, ,, Diana	450	September 26	Spica rising
	Pœstum	,, ,, Neptune	535	March 22 ...	Spica setting
South Italy..	Pompeii	Doric Temple in triangular Forum	640	November 12	Antares rising
	,, ...	Temple of Isis	750	June 19 ...	β Geminorum rising

For the sake of comparing the above with dates that are archæologically probable, and confining the inquiry to the Greek colonies, we may observe:

The Doric capital at Taranto is of an extremely ponderous type, and may well be assigned to the seventh century. A Lacedemonian colony under Phalanthus is reported to have taken possession of Tarentum about 700 B.C.

At Metapontum, at the temple near San Sansoni, nothing but foundations remain; the architectural character of the other is quite in accordance with the orientation date. The city was one of the most ancient in South Italy. One column only remains of the temple on Cape Colonna near Cotrone, and its character is that of the fifth century. In the case of this celebrated temple we clearly have the case of a rebuilding on the old lines.

The foundations of the older temple of the Locrians near Gerace were discovered under the substructions of the later temple. Its orientation date, 610, is quite consistent both with the early Ionic architecture which was found, and that of the Hellenic colonisation, 683 B.C. That of the later temple is also in accordance with the architecture of the fifth century. Girgenti was occupied by a Greek colony B.C. 582, but a city with so commanding a site had, no doubt, an earlier foundation; and we may feel confident that the temple of Juno Lacinia, though the present structure is Hellenic, was founded by the earlier inhabitants. The remains of the other temples agree in style with the dates assigned to them by the theory. Mention is made by Diodorus of the temple of Jupiter strongly confirmatory of the orientation date 430 B.C. At Segesta the date arrived at is too early by about 100 years to agree with the character of the architecture. It may have been that the Segestans, who seem always to have been a struggling community, may have taken a very long time to have brought their temple to the state of finish at which at last it arrived, for it appears never to have been quite completed.

Selinus offers the example of one temple—a temple remarkable for the archaic character both of its masonry and its sculpture—of which the orientation date anticipates the arrival of the Hellenic colony which occupied the place in 628 B.C., but in the other examples in that city the orientation dates are quite consistent both with the architecture and with Hellenic citizenship. Syracuse was colonised in 734 B.C. The orientation date of the "Duomo" temple is eighty years too early for agreement with that epoch. The architecture is indeed very rude, but perhaps some small variation in the elements of the calculation should be made, which would bring it within the Hellenic period. The dates of the other two temples at Syracuse are extremely probable. The date, 535 B.C., assigned to the Temple of Neptune at Pœstum, appears to be thoroughly suitable to its massive but advanced style, and is confirmed by a passage in Herodotus, in which, although he does not make any allusion to the temple, yet speaks of a Posidonian architect of great celebrity at that very date. The temple of Isis at Pompeii is remarkable from there being evidence of a large window having been formed in the temenos wall centrally placed with regard to the eastern axis of the temple, doubtless for the admission of the rising sun and its warning star. The window had been filled up with brickwork at some subsequent date. The last point touched upon in the paper has reference to a group of ten temples of late foundation, of most of which the dates are accurately known. At first these temples seemed to be exceptions to the rules which connect the orientation with heliacal stars, but by allowing a few more degrees of solar depression than what is absolutely necessary for distinct vision, they are found to conform in all other respects. The explanation

of this change seems to be that the temple service had become more complicated, and more time was required by the priests for their preparations. Every additional degree of sun depression would add about five minutes for that purpose. The maximum extra allowance in this group of temples is thirty-five minutes.

F. C. PENROSE.

NATURE AND A CAMERA.[1]

THE remarkably favourable reception accorded by the public and the press to the earlier effort of the Messrs. Kearton has naturally tempted them to another venture; and the volume before us shows no falling off in the matter of interest and the exquisite execution of the illustrations from its predecessor. Only too frequently authors, having scored one success, are apt to think their hold on the public will permit of a very inferior second effort obtaining the same share of patronage as the first, and any odd scraps of new information they

FIG. 1.—Nightingale on Nest. (From "With Nature and a Camera.")

may possess are, with the aid of abundant "padding," worked up to form a volume of the required dimensions. The present work displays in an equally marked degree the freshness and brightness so conspicuous in "British Birds' Nests"; and as covering a wider area is calculated to attract an even larger circle of readers. One of the best tests of a work of this nature is its capability of arousing the interest of young persons, and this, from practical experience, we find to be the case with the volume before us.

Photography in the hands of artists of the capacity and perseverance of Mr. Cherry Kearton is undoubtedly the only real method of portraying animals in their native haunts, and more especially birds on their nests; and in the truthful representations of objects of the latter class the present volume can fear few rivals. Nothing can be more exquisite than the illustration of a nightingale on her nest, which the publishers have permitted us to reproduce (Fig. 1); but this is only one among many of the same excellence and interest, those of the whitethroat and the chiffchaff being, if possible, even more beautiful. The only thing we miss in illustrations of this nature is colour, which would be of especial value in photographs, like the upper one on page 253, dealing with the protective resemblances of animals to their surroundings. Possibly even this want may be supplied in the near future.

But it is by no means the beauty of the illustrations alone that calls for commendation in the work; many of the observations in the text claim recognition from all interested in the habits of British animals, while some have a bearing on considerations of a higher nature. For instance, in regard to protective resemblance, Mr. Kearton says he is puzzled by the circumstance that while young terns instinctively recognise its value, some of their parents apparently do not and others do. This is exemplified as follows: "As a rule, Sandwich terns' eggs harmonise closely with their surroundings, and even the experienced field naturalist has to exercise a great deal of care to avoid treading upon a clutch when visiting a breeding station. A friend of mine told me a few years back that he had once visited a colony of these birds on an island where the natural breeding accommodation was so limited that many of them had conveyed patches of pebbles on to the grass, and laid their eggs thereon. We both recognised this as a wonderful instance of the knowledge of the value of protective coloration; but I must confess that last summer at the Farne Islands my faith in the wisdom of these birds received a rude shock when I met with five or six clutches of eggs lying most conspicuously on small circular patches of broken mussel-shells, the dark blue of which contrasted violently with the golden grey of the sand." From this it would almost seem that the birds are unable to distinguish between a mussel-shell and a pebble, and that any cluster of small smooth objects looks to them equally suitable as a nesting site.

Although the greater portion of the work is devoted to birds in their haunts, the subjects treated of are diverse. To the general reader and tourist the chapters on the people and birds of St. Kilda will, perhaps, be the most interesting; while the sportsman will find much to attract him in those on gamekeepers and duck-decoying. To the amateur photographer the volume will appeal not only as a standard of excellence at which to aim as regards his own efforts, but more especially from the account given in the final chapter of Mr. Kearton's method of photographing. From this latter it will be apparent that the task of portraying many kinds of birds—especially when they inhabit lakes or beetling sea-cliffs—in their native haunts, is no easy one, but rather one beset with numerous dangers to life and limb. In the preface the author deprecates the charge of foolhardiness, and the results obtained go far to justify the risks necessarily incurred.

In the chapter on sea-birds and their haunts will be found some of the matter most interesting to the ornithologist, and it is here that some of the most successful of the photographs occur. As an example, we select, partly on account of its small size, the figure of a solitary razorbill mounting guard over its egg reposing lower down on the side of a pinnacle of rock (Fig. 2). But for beauty of detail and execution we may refer to the gull's nest with egg and young, and the group of puffins on p. 269, and also to the nest of the black-headed gull on the following page. To obtain the photograph of gannets nesting on the Bass Rock, Mr. Cherry Kearton ran risks

[1] "With Nature and a Camera, being the Adventures and Observations of a Field-Naturalist and an Animal Photographer." By R. Kearton, with Photographs by C. Kearton. 8vo. Pp. xvi + 368, illustrated. (London: Cassell and Co., Ltd., 1897.)

which evoked the fear of even the adventurous natives of the district. When once their haunts are gained, gannets with young are however, according to our author, very easy birds to photograph, as they will permit the observer to walk among them with no more protest than an occasional peck at his legs. Much has of late years been written on the destruction by human agency of our sea-birds; and it is, therefore, of interest to note that other causes likewise aid to no inconsiderable extent in the diminution of their numbers. "The mortality among sea-birds of all kinds," writes our author, "reckoning the loss of eggs and young ones, from purely natural causes alone, must be very great in the course of a season. We saw a great number of young terns lying dead everywhere upon these islands, and Watcher Darling told us that two years ago very few Arctic or common terns got away. He picked up several dead

FIG. 2.—Razorbill and Egg. (From "With Nature and a Camera.")

ones with sand-eels in their bills, and concluded that there was no small fry for them, and that the eels, although the natural diet of Sandwich terns, were too large for the young of the smaller species to swallow."

Most of us suppose that the eider is pre-eminent for the quantity of down she employs for lining her nest; but in this, according to our author, she is beaten by the common wild duck. Did space allow, many other observations of equal interest might be quoted, but for these we must refer the reader to the work itself, which will form a welcome Christmas gift to all, whether young or old, interested in wild nature. R. L.

DR. FRIEDRICH A. T. WINNECKE.

IT is always a painful duty to review the life work of those who have recently passed away, to estimate the position their names will occupy in the history of a science, and to survey the grounds on which their reputation will finally rest. But in the case of Dr. Winnecke, whose death was recorded last week, the task becomes both painful and difficult. Thirty years ago he occupied a prominent position among continental astronomers, and was intimately connected with the onward growth and development of the science in many important directions. His enterprise and ability were everywhere acknowledged, and a long career of work and usefulness seemed before him. But while he was still a comparatively young man, the state of his health prevented him from adding to the reputation he had established, and to-day his name is perhaps little more than a memory to many, who, interested in newer problems and more sensational inquiries, may possibly undervalue the work of an older school, which occupied itself mainly in the astronomy of position. But wherever a just and comprehensive view of astronomy as a whole is taken, Winnecke's work will be remembered with gratitude and admiration.

Dr. Winnecke enjoyed the advantage of admirable mathematical training under competent teachers. The school of Bessel was then in the ascendant, and the reputations of Encke and of Argelander were at their zenith; while in the district of Hanover, where Winnecke passed his early years, the memory of Herschel was still treasured, and helped to give direction to his astronomical tastes. He received his training in practical astronomy mainly at Bonn, under Argelander, where he became a proficient in the use of the heliometer, and with this instrument effected a complete triangulation of the stars in the Præsepe cluster, together with a thorough examination of the necessary constants of reduction. This latter part of the work he prepared himself for publication, but never printed, and it forms a painful commentary on his enfeebled energies to remember that this work never saw the light till many years after, when Dr. Schur proved himself an able and sympathetic coadjutor, and arranged the numerical portion of the research for general use. In 1858, Winnecke left Bonn for Pulkova, where he still interested himself in extra-meridional work. The fine series of observations of the great comet of 1861, which he followed until May 1862, long after it had ceased to be observed in other telescopes, and on which the final orbit rests, is a proof of both his energy and his observational skill. Cometary astronomy always had for him great attractions, and besides the periodic comet which bears his name, he found several others, receiving the prize of the Vienna Academy of Sciences for his cometary discoveries. At Pulkova, too, he took some part in the geodetic work arranged between Dr. Otto Struve, Argelander, and the late Astronomer Royal, for determining the differences of longitude between places on the great European arc of parallel, and, in conjunction with Colonel Forsch and Captain Zylinski, carried through that portion of the scheme which connects Haverford West with Nieuport and Bonn.

Winnecke also bestowed some attention on the problem of the sun's distance, which forty years ago was a burning question. Hansen and Le Verrier were contending for the rejection of Encke's value of the parallax as the outcome of mathematical investigations based on the lunar and planetary theories, and were supported by the result of Foucault's mechanical operations arranged to determine the velocity of light. Winnecke was among the first to perceive the importance of obtaining evidence from independent sources, and fully appreciated the value of utilising the observations of Mars as a new element in the discussion. The result of his investigation of the observations made at the 1862 opposition was to assign to the Solar Parallax a value of $8''.964$, confirmed by Stone's result of $8''.932$.

After leaving Pulkova, Winnecke settled for some years in Karlsruhe, where he was an industrious observer of comets and variable stars. On the conclusion of the Franco-German war, he was invited to take charge of the new observatory at Strassburg. The equipment of this observatory and the details of its arrangement are due to his superintendence, and it certainly ranks among

the best arranged of continental observatories. While in the position of Director, Winnecke's health finally broke down, and for a great many years he has been unable to take any part in the management of the establishment he had so admirably fitted and equipped. W. E. P.

NOTES.

The Physico-Chemical Institute of the University of Leipzig, of which Prof. W. Ostwald is director, will be formally opened by a ceremony to be held in the large lecture theatre of the Institute on January 3.

Dr. Hugh Galt, acting Professor of Forensic Medicine and Public Health at Glasgow University, has for some time back been engaged in a research upon the starches, which is likely to prove of value to the Department of Public Health.

Mr. John Milne writes that arrangements have been made for the establishment of horizontal pendulums, with photographic apparatus to record unfelt movements, at Toronto, Harvard, Philadelphia, Victoria, B.C., New Zealand (two), Batavia, Madras, Calcutta, Bombay, Mauritius, the Cape, Argentina, San Fernando, and Kew, whilst a number of other stations are under consideration. Seismograms have already been received from Toronto. At his station on the Isle of Wight, for purposes of comparison, Mr. Milne has also two horizontal pendulums writing on smoked paper, and very shortly a Darwin bifilar pendulum is to be established. To this will be added later a von Rebeur-Paschwitz apparatus, with which type of apparatus Mr. Milne worked for many years in Japan.

Dr. Charrin has been appointed to succeed Prof. d'Arsonval in the chair of Medicine of the Collège de France.

A new branch of the Russian Geographical Society has just been opened at Tashkend, for Turkestan.

On December 4 the friends and pupils of Dr. C. Cramer, the professor of botany at Zürich, celebrated the fortieth anniversary of his connection as teacher with the Polytechnic in that town.

Prof. Dr. Willi Ule has just taken over the editorship of the weekly scientific periodical *Die Natur*, which was founded by Dr. Otto Ule and Dr. Karl Müller, and is now in its forty-sixth year of publication.

We regret to see the announcement of the death of Mr. Gardiner G. Hubbard, President of the National Geographic Society, Washington. The death is also announced of Dr. Campbell Morfit, formerly professor of applied chemistry in the University of Maryland, and one of the scientific advisers of the United States Government.

At the close of a lecture delivered by Lieut. Peary in Edinburgh on Friday last, under the auspices of the Royal Scottish Geographical Society, Dr. J. N. Murray, on behalf of the Council of the Society, presented him with the medal of the Society in recognition of his work in the Arctic regions.

A Brooklyn correspondent sends this item of news:—'Prof. Langley and Prof. Elfreth Watkins have constructed a flying machine designed to draw a railroad car. This has been tested for several days on the Medford branch of the Pennsylvania Railroad, near Mount Holly, N.J., and has drawn the car at the rate of six miles an hour. The machine is actuated by a gasoline engine, the power being applied to two propellers, about four feet long, which make 800 revolutions per minute. It is expected that machines can be constructed on this principle, which can draw cars at the usual railroad speed."

We learn from *Science* that Dr. George H. Horn, the eminent entomologist, died at Philadelphia on November 25. He was one of the Secretaries of the Philosophical Society, and was formerly Corresponding Secretary of the Academy of Natural Sciences. He had been until recently professor in the University of Pennsylvania, though his connection with that institution was chiefly honorary. Dr. Horn was only fifty-eight years of age, and his death, following those of Cope and Allen, is a further severe loss to the city of Philadelphia and to science in America.

La Nature announces the death of Prof. A. Joly, director of the chemical laboratory of the École normale Supérieure, and professor in the Paris Faculty of Sciences. Born at Fontenay-sous-Bois in 1846, M. Joly entered the Normal School in 1866. When he left this school he became attached to Saint-Claire Deville's laboratory, and afterwards was professor of physics at the lycée Henri IV., which post he occupied until he was nominated sub-director of the laboratory of the Normal School. The titular director of the laboratory at that time was M. Debray. M. Joly next became instructor (maître de conférences) in chemistry at the Sorbonne, and then professor attached to the Faculty of Sciences of Paris. His works refer principally to the rare metals (niobium among others) and acids of phosphorus.

The first ordinary meeting of the Röntgen Society was held on December 7, Dr. Gladstone, F.R.S., being in the chair. Mr. A. A. Campbell Swinton read a paper on "Adjustable X-ray Tubes," in which various methods were discussed for regulating the penetrative and other qualities of X-rays, and for compensating the unavoidable and troublesome variations in vacuum that are found to occur in practice. The paper was illustrated by numerous experiments, and several adjustable tubes of Mr. Swinton's design, embodying the improvements and principles enunciated, were shown in operation.

The ninth Congress of Archæological Societies was held at Burlington House on December 1, the Right Hon. Viscount Dillon in the chair. The Hon. Secretary reported that the Committee had authorised the completion of Mr. Gomme's Index of Papers from 1682, with a view to immediate publication. It was reported that a wish had been expressed to have an index of the archæological articles in certain journals and publications, other than the *Transactions* of Societies. The Standing Committee had considered the subject, and recommended that if anything were done it should be by adding a supplement to the Index as now published. After discussion the question was referred to the Committee with power to act, if they found they could do so to advantage and at reasonable expense. It was resolved, on the motion of Sir John Evans, K.C.B.: "That a memorandum be sent to the various local Archæological Societies, suggesting the desirability of placing themselves in communication with the Ordnance Survey officers for their districts so as to promote the record on the surveys of the earthworks within their districts, and where possible to determine their age by excavations." Mr. C. Hercules Read, the Secretary of the Society of Antiquaries, made a statement as to the steps that had been taken by Government in response to the request of the Society of Antiquaries for information as to what is done in foreign countries for the protection of ancient and historical monuments. Full information had been obtained and would shortly be published in a Blue Book. It appears that in no country in Europe is so little protection given as in England. Mr. Hope read a draft report on the best mode of indexing the *Transactions* of Societies; this had been prepared by the Committee consisting of himself and Mr. J. H. Round and Mr. Gomme. As it appeared that several Societies were anxiously waiting for the recommendations, it was

agreed that the report should be referred back to the Committee for final consideration, and that as soon as complete it should be issued to the Societies. The Hon. Secretary reported that a National Photographic Record Association had been formed under the presidency of Sir J. Benjamin Stone, M.P., who had been at the head of the original Warwickshire Survey. He was directed to communicate to the Association that "The Congress hears with great satisfaction of the formation of a National Photographic Record Society, and expresses its desire to assist the work in any way it can."

MR. W. A. KNIGHT, writing from Bruton, Somerset, informs us that on November 30, at 10.20 p.m., he was fortunate enough to observe there a splendid lunar rainbow. The moon was sufficiently near the horizon to give a large arc, and although it was scarcely quarter-full, the black clouds looming in the north-east made the bow appear quite bright. There appears to be no doubt that what Mr. Knight saw was a lunar rainbow and not a halo, for it was opposite the moon.

PROF. A. RIGGENBACH has sent us the results of seven years' rainfall observations at Basle, deduced from a self-recording gauge. Of course the period is very short, and in dealing with monthly and annual means the author combines the values with those of an ordinary gauge, giving altogether a series of thirty-three years. But the principal object of the paper is to bring out some interesting details, which cannot well be obtained from an ordinary gauge. Among these we may mention the frequency and duration of very heavy showers, the great majority of which last only about twenty minutes. Sixty per cent. of these occur between 1h. and 7h. p.m., and 87 per cent. occur between June and September. In the yearly range the rainfall probability reaches a maximum in the early summer and in the late autumn, while the minima fall in mid-summer and in the first months of the year. In the daily range the duration of rainfall reaches a maximum between 6h. and 8h. a.m., and falls to a shallow minimum at 7h. to 8h. p.m., after which it rises uniformly to the maximum again. The various phases are shown both in tabular and graphical form. Dr. Riggenbach is perhaps best known to English meteorologists by the success with which he has prosecuted cloud photography.

HERR OTTO BASCHIN contributes to the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* an account of the fitting out and departure of Andrée's balloon expedition. The different possibilities as to the fate of the explorers are discussed, and the conclusion reached that there is as yet no reason to give up hope of their return. Under the most favourable circumstances the balloon might easily deposit its passengers on a part of Northern Siberia, from which it would take months to reach the nearest telegraph station.

THE new number of the *Mittheilungen von Forschungsreisenden und Gelehrten aus den deutschen Schutzgebieten* contains some items of geographical interest. Dr. F. Stuhlmann contributes a paper on the German-Portuguese frontier in East Africa, with a new map of the mouth of the Ravuma. In the same region Lieut. Stadlbaur gives a short account of the Turu district and its people; whilst First Lieutenant Freiherr von Stein describes the Ossa or Lungasi lake, on a tributary of the Savaga in the Kameruns.

DIFFERENT minds place different estimates on the intellectual accomplishments of the past half-century. In ordinary conversation the men of the mart will point to an Eiffel tower, a suspension bridge, a continental express train, a man-of-war, or an Atlantic cable. But in a discourse recently delivered in commemoration of the jubilee of the Sheffield Scientific School of Yale University, President Gilman remarked that perhaps the greatest triumphs of the intellect during the last half-century are these five contributions to human knowledge: the establishment of the principles of evolution; the establishment of the principle of the conservation of energy; the development of mathematical science and its application to physics, mechanics, electricity and astronomy; the development of spectrum analysis and the consequent discoveries respecting light and electricity; and the discovery of the nature and functions of bacteria, and of their influence, for weal or woe, upon living organisms.

As the result of an investigation of the red spectrum of argon, Dr. J. R. Rydberg comes to the conclusion (*Astrophysical Journal*, November) that it belongs to one single element. Moreover, there seems to him to be no reason to doubt that the blue spectrum belongs to the same element, but corresponds to a higher temperature. As to the supposed displacement of a great number of the lines of the white spectrum towards the red end of the spectrum, it is remarked, "nothing seems to indicate that we have to do with a *continuous* displacement, but rather with the appearance of new lines on the red side of those of the other spectra, with which they ought to be closely related. In such a case it seems most probable that the interesting observation of Eder and Valenta depends on a change in the relative intensity of two sets of connected lines."

IN the *Philosophical Magazine* for December, Mr. J. D. Hamilton Dickson examines the relation between the electric resistance of a metallic wire and the temperature. Although it has been demonstrated that platinum is a suitable substance for determining temperatures over a very wide range, not much different probably from 2000° C., nevertheless, seeing that each platinum thermometer needs at least to have its constant specially and carefully determined, not by three, but by a series of observations, it cannot be too strongly urged that this work should in each case accompany the record of results when expressed in platinum temperatures; and no one will deny that to have these results expressed at once in terms of the normal air-thermometer will permanently enhance the value of the work in such a manner as to amply recompense the extra labour. With the view of helping towards this desirable end, Mr. Dickson proposes a formula of the form $(R+a)^2=p(t+b)$, where a, p, b are constants, and gives reasons for considering it as more representative of the connection between temperature and resistance than any formula hitherto proposed, and just as simple as any.

AN interesting extension to space of n dimensions of Euler's and Meunier's theorems on the curvature of surfaces has been given by Signor Luigi Berzolari in the *Atti dei Lincei*, vi. 10. The author proves the following propositions:—Given in S_n a form of $n-1$ dimensions, the curvature (of Kronecker) at any point of any hyperplane section is equal to the curvature of the hyperplane section having the same trace on the tangent hyperplane at that point divided by the $n-2$th power of the cosine of the angle between the hyperplanes. The curvature of the normal hyperplane section at O is a maximum when the trace of the cutting hyperplane on the tangent hyperplane at O is one of the principal sections S_n-2 of the indicatrix, and the sum of the curvatures of any $n-1$ hyperplane normal sections mutually at right angles is constant.

DETERMINATIONS of the thermal conductivity of ice by different observers have hitherto exhibited a remarkable discrepancy of results, the values of this coefficient being, according to F. Neumann, 0·34; De la Rive, 0·14; Forbes, 0·134 and 0·128, according to direction; and, according to Mittchel, 0·30, the centimetre, gramme, minute and degree Centigrade being taken as units. In the *Atti dei Lincei*, vi. 9, Signor Paolo Straneo describes a simple method of determining this coefficient. From observations on two different kinds of ice, taking two different cubes of each, the values obtained are 0·307, 0·309 for

one kind, 0·312 and 0·313 for the other. A further determination gives 0·304 for the first kind; hence, generally, *k* lies between 0·30 and 0·31. Noticing that certain kinds of ice are anistropic, the properties being different along the vertical and horizontal directions referred to the position when frozen, Signor Straneo, in a subsequent paper, investigates the question as to whether the thermal conductivity varies with the direction. In homogeneous amorphous ice the values for the vertical and horizontal directions were found to be practically equal (0·312 and 0·308), but homogeneous non-amorphous ice gave for the same directions 0·328 and 0·301 respectively in one experiment, and 0·325 and 0·308 in another, showing that only ice which is not perfectly amorphous presents small differences in the coefficient of conductivity in different directions.

THE physical aspect of the reversal of the photographic image is the subject of a suggestive paper by Captain Abney in the *Journal* of the Camera Club. To investigate the matter, a series of photo-micrographs of sections of films which had been given known exposures was taken. From these sections it is seen that the part of the films in which reversal has taken place are markedly different at the upper and lower surfaces. Near the upper surface the section shows comparatively fine grains of silver, whilst at the bottom surface it shows coarser grains. At the top part of the film, where the light has acted strongly, the reversal has taken place. At the bottom the light has not acted much more than usual, owing to the shielding action of the top part. When given areas of the film are examined, the numbers of separate silver particles are found to be very much the same in both cases, showing that there is a sort of normal number per volume which is subject to reduction, and that the main difference is in the *size* of the reduced particles. In the course of a discussion upon the subject of the paper, Dr. Armstrong, referring to the sections of the unreversed image, considered that Captain Abney had shown that to be the case which must be the case, and that so long as there was no reversal the particles must be practically as large as the bromide particles, and all of the same dimensions. By showing that the particles in the reversed image were so very much smaller, Captain Abney had contributed in an important degree to the solution of the character of the change that took place; it appeared to him that it had been shown that there was in some way a reconversion of the surface of the particle into soluble matter—that evidence had been adduced to prove that there must be a re-transference of the bromine back into the silver at the surface, leaving untouched the silver lower down in the particle, and consequently that when the fixing solution was applied, the particle became reduced in size.

AN article of perhaps no little interest to many persons in this country, and of some substantial importance to Spanish industries, is the so-called gut from silkworms. This is useful for fishing purposes, partly on account of its great tenacity and partly owing to its transparent quality, the line attaching the hook when in the water not being visible. The manner of obtaining this threadlike gut is described in the *Journal* of the Society of Arts as follows:—After the grub has eaten enough mulberry leaves and before it begins to spin, which is during the months of May and June, it is thrown into vinegar for several hours. The insect is killed, and the substance which the grub, if alive, would have spun into a cocoon, is forcibly drawn out from the dead body into a much thicker and shorter silken thread. Two thick threads (from each grub) are placed for about four hours in clear cold water, after which they are dipped for ten or fifteen minutes in a solution of some caustic, for which purpose soft soap dissolved in water is used. This serves to loosen a fine outer skin, which is next removed by the hands while the workman holds the thread between his teeth. The silk is then hung up to dry, care being taken to choose a shady place, as the sun has the effect of making them too brittle afterwards. In some parts of the country these silk guts are bleached with sulphur vapour, which makes them look beautifully glossy and snow-white, like spun glass, while those naturally dried retain always a yellowish tint.

THE current number of the *Annali d'Igiene Sperimentale* contains a note by Dr. Casagrandi on a yeast producing a red pigment which, in many respects, resembles the one described by Demme some years ago, and isolated by him from a cheese. Demme stated that his variety was not endowed with any fermentative properties; that isolated by Casagrandi, on the contrary, ferments glucose very readily. This fermentative power is not, however, a trustworthy one for establishing differences between very similar varieties of bacteria, for, as in other cases so in this, Casagrandi has found that Demme's yeast can be induced to ferment glucose if particular precautions are adopted. Both Demme's and Casagrandi's specimens are pathogenic to guinea-pigs, rabbits and rats, when subcutaneously introduced into these animals; whilst of much interest is the fact that when grown in milk they are both capable of so modifying the character of this liquid that dogs and rabbits fed with such milk develop diarrhœa, and the same symptoms have been observed in babies which had partaken of milk in which this red yeast had been growing. This yeast appears to be present in our surroundings, and may, therefore, at any time make its presence felt by obtaining access to milk if the latter is left unduly exposed. We already have one well-recognised red yeast, the so-called *Rosa hefe*, but Casagrandi does not claim that his variety is anything more than an offshoot from the second red yeast, known to us as the *Saccharomyces ruber* discovered by Demme some seven years ago.

NO. 11, vol. iii., of *Spelunca* contains, among much other cavern-lore, an illustrated account of M. Martel's explorations in the British Isles in 1895.

IN the November number of the *Irish Naturalist*, Mr. G. H. Kinahan urges the importance of a careful study of quartz-rocks, when not metamorphosed, with a view to the recognition of structures that may prove some of them to be of organic origin, like the modern sinter produced by the algæ of hot springs.

MR. W. JEROME HARRISON has reprinted, from the *Glacialists' Magazine*, "A Bibliography of Norfolk Glaciology," on the lines of his similar work on the Midlands. Over four hundred papers are catalogued, in approximate order of publication, and short abstracts of the most important are given. There is also a list of the Geological Survey maps, and an author-index. A reproduction of a photograph of one of the great chalk-masses in the drift of Runton forms a frontispiece to this useful reprint.

To commemorate the incorporation of the University College of Sheffield, a number of scientific papers by members of the College have been brought together and printed in a volume for private distribution. The subjects of physical papers included in the volume are:—The influence of carbon on iron, by Prof. J. O. Arnold; the preparation of pure iron by electrolysis, by Prof. W. M. Hicks, F.R.S., and Mr. L. T. O'Shea; vortex aggregates with gyrostatic quality, by Prof. Hicks; functions connected with tesseral harmonics, by Prof. A. H. Leahy; superheated steam-engine trials, by Prof. W. Ripper; the amount of carbonic anhydride in the atmosphere, by Prof. W. Carleton Williams; and contributions to the knowledge of the Triazole series, by Dr. George Young. In biological science there are papers on the comparative intellectual value of the anterior and posterior cerebral lobes, by Dr. C. Clapham; the development of the ovipositor in *Periplaneta orientalis*, by Prof. A. Denny;

the preparation of marine animals and plants as transparent lantern slides, by Prof. H. C. Sorby, F.R.S.; and the shape and position of the pancreas and the adjoining viscera, by Prof. C. Addison. The editing committee state that the volume "is presented as an earnest that the new College may in the future be distinguished, not only for the number of students it has trained, but also as a place for the advancement of knowledge." We accept the token, and from its character we are sure that the University College of Sheffield will not be behind in valuable contributions to science.

The number of cuprous salts at present known is very small in comparison with the large number of stable cupric salts that can exist. The isolation of cuprous sulphate, in particular, has not yet been effected. In the current number of the *Comptes rendus* of the Paris Academy of Sciences there is an interesting account, by M. A. Joannis, of some attempts to isolate this salt, which, although unsuccessful, tend to prove that cuprous sulphate can be formed under certain conditions. Finely divided metallic copper digested with a solution of cupric sulphate, as is well known, undergoes no change. If, however, carbon monoxide is led in, a slow absorption takes place, the copper dissolving, and the solution becoming decolorised. These facts can be accounted for by assuming that cuprous sulphate is formed which combines with the carbon monoxide to form a compound analogous to that obtained from cuprous chloride. The decomposition of this solution when the gas is removed by the mercury pump is somewhat remarkable, for as soon as the pressure is reduced to about 2 mm. a pellicle of metallic copper forms on the surface, and the solution becomes blue, the reaction between cupric sulphate, copper, and carbonic oxide being in fact a reversible one and a function of the pressure of the gas.

From the December *Journal* of the Chemical Society, we derive the following particulars of a paper on the production of sugars in beetroot, by Friedrich Strohmer:—The opinion expressed thirty years ago by H. Schacht, that the quality of beetroots depends on the number of developed leaves and the length of life of the plant, is now shown to be free from objections. Sugar is produced in the leaves, either directly as reducing sugar, or from starch or other carbohydrate, and migrates through the leaf stems to the root. The production of sugar depends on the amount of light, and the form and position of the leaves are of importance. When the sunlight passed through white or yellow glass, leaf production was vigorous, but with blue or red glass feeble; and the weight of roots under the influence of yellow light was nearly twice as great as when blue and red light were employed. The percentage of sugar under the different conditions was 7·4–8·1 with yellow, 6·4–7·4 with red, and 8·0–8·4 with blue light. For producing total organic substance in beetroot, rays of medium wave-length are the most favourable, but for converting the products of assimilation into sugar, the so-called chemical rays seem to have a prominent *rôle.* The results of field experiments showed that sugar production begins at an early stage in the leaves, but is greatest from the beginning of August to the middle of September. Under favourable conditions, there may be a not inconsiderable accumulation of sugar even later. From the beginning of July, the sum of the percentages of water and sugar in the roots is constant. This, and the fact that the percentage of sugar in the roots increases until the leaves die, indicates that the sugar, once stored in the roots, remains there. It is only when the roots are taken out of the soil and the leaves cut off, that the sugar begins to be used up in maintaining the life of the plant and in preparation for second year's growth.

The additions to the Zoological Society's Gardens during the past week include an Ocelet (*Felis pardalis*) from Para, presented by Mr. William Wethered; an Arctic Fox (*Canis lagopus*) from the Arctic Regions, presented by Mr. H. E. Wood; a Dominican's Cat (*Felis dominicanorum*), two White-legged Falconets (*Microhierax melanoleucus*), a White-browed Laughing Thrush (*Dryonastes sannoi*), a Collared Jay Thrush (*Garrulax picticollis*) from the province of Foochoo, China, presented by Messrs. C. B. Rickett and J. De la Touche; four Burrowing Owls (*Speotyto cunicularia*) from Argentina, presented by Miss Sandys Lumsdaine; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Miss M. L. Peake; a Golden Eagle (*Aquila chrysætus*) from Newfoundland, two Black-necked Swans (*Cygnus nigricollis*, ♂ ♀) from Antarctic America, purchased; a Crested Porcupine (*Hystrix cristata*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Oppositions of Two Minor Planets.—The minor planet Ceres will be in opposition to the sun on the 25th of this month. (For elements and coordinates see pages 2 and 3 of Appendix to Nautical Almanac 1897.) Although Ceres is the largest of the asteroids, it is interesting as having to give precedence to Vesta for brightness; the stellar magnitude at this opposition will be 7·1. Ceres is now describing a retrograde path on the borders of Auriga and Gemini, near ϵ Geminorum, and has therefore a considerable altitude.

There is also an opposition, on the 26th inst., of one of the fainter and less well-known minor planets, viz. Gerda, the elements and coordinates for which, as given by M. A. Iwanow, of Pulkova, will be found in *Astr. Nach.*, 3458. At the time of opposition the asteroid will be near to ν Geminorum.

The Total Solar Eclipse of 1900.—Prevision is always a desirable attribute, and to an astronomer it is essential. We are reminded of this by an account given by Prof. Frank H. Bigelow, in the *Monthly Weather Review*, of the probable meteorological conditions along the path of the total eclipse of the sun, in the United States, on May 28, 1900. Beginning with May 15, of this year, and continuing until June 15, so as to include May 28 centrally, meteorological observations were made at sixty-six stations distributed uniformly over the portions of the States of Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, and Louisiana, crossed by the eclipse track. Observations were made of the general state of the sky at 8 a.m., 8.30 a.m. and 9 a.m., and also of the state of the sky near the sun. The results show that the conditions in the interior of Georgia and Alabama were better than in North Carolina, South Carolina, or Louisiana. Apparently it would be safer to establish eclipse stations in central Georgia or Alabama, upon the southern end of the Appalachian mountains, where the track crosses the elevated areas, than nearer the coast-line in either direction, north-eastward towards the Atlantic coast or south-westward towards the Gulf coast.

It is intended to repeat the observations during the years 1898 and 1899, so as to obtain as good information as possible with regard to suitable eclipse stations for the year 1900.

Corrected Position of the Moon.—It will be remembered that the Pleïades have been quite recently occulted twice by the moon, once in July and again in October. These occultations were specially observed at Lyons, and in No. 22 *Comptes rendus*, vol. cxxv., M. Lagrula shows that in a series of occultations of stars by the moon, observed at epochs sufficiently near together, it can be supposed that the corrections to apply to the tables of our satellite vary proportionally with the times. It is then possible from these to combine the equations of condition supplied by the different phenomena observed. Thus we can obtain with great precision the semi-diameter and the coordinates of the moon at the mean epoch, and even in certain cases her parallax. The two important occultations discussed are those which took place on July 23 and October 13, 1897. The results are given in the following table, where D and π represents the semi-diameter and the parallax of the moon at her mean distance; Δx and $\Delta\delta$ the corrections in R.A. and declination, which ought to be applied

to the coordinates in Hansen's tables, corrected from Newcomb's numbers.

Paris Mean Time 1897 d. h. m.	D ′ ″ ″	π	$\Delta\alpha$ s. s.	$\Delta\delta$ ″ ″	No. of Obs.
July 23 13 9	15 32·87 ± 0·14	indeterminate	+ 0·30 ± 0·01.	− 0·1 ± 0·2	36
Oct. 13 14 5	15 32·86 ± 0·24	57′ 3″·2 ± 1″·0	+ 0·31 ± 0·02.	+ 0·5 ± 0·4	29

A NEW FORM OF MIRROR FOR A REFLECTING TELESCOPE.—During the dedication exercises held in connection with the Yerkes Observatory, Dr. C. L. Poor advocated and exhibited a reflecting telescope in which the mirror is a portion of a paraboloid of revolution cut from the surface near the extremity of the latus rectum. The reflected rays then being at right angles to the incident rays, no dome would be required for such a telescope, and there would be no secondary mirror. This form of telescope was, however, recommended by Prof. Pickering more than sixteen years ago (NATURE, 1881, August 25); moreover, Prof. Schaeberle shows in the *Astronomical Journal*, No. 419, the inefficiency of such an instrument, from the following considerations. Let L denote the distance from the focus to the centre of the mirror, which is evidently inclined about 45° to the line of sight. If D denotes the minimum diameter of this elliptical mirror, the maximum diameter must be D sec. 45° if a circular cone of rays is to be used. The linear distance from the focus to the nearest and most distant points of the mirror will then be approximately—

$$\text{Least distance} \quad = \text{L} - \tfrac{1}{2}\,\text{D sec } 45°.$$
$$\text{Greatest distance} = \text{L} + \tfrac{1}{2}\,\text{D sec } 45°.$$

If we assume $\frac{\text{L}}{\text{D}} = \frac{7}{1}$, the greatest distance divided by the least distance becomes 1·22.

This quantity is approximately the *blurring factor* for the given ratio of focal length to aperture for this form of instrument. For a star which is only 5′ from the optical axis of the telescope, and in a place containing the longer axis of the mirror, the image will, therefore, be a line no less than 66″, or more than a minute of arc.

Exactly at the focal point this star image will be a point, but for all other positions of the image the definition will be unworkable.

RECENT RESEARCHES ON TERRESTRIAL MAGNETISM.[1]

THE science of terrestrial magnetism has on one previous occasion formed the topic of a Rede Lecture. Twenty-five years ago Sir E. Sabine delivered a discourse on this subject, with which his name will always be honourably connected. The length of time which has elapsed may perhaps justify a return to the same theme, though it must be admitted that now, as then, the study of the magnetic properties of the earth is in an early stage of development. It is true that considerable advances have been made in the theory of the nature of magnetism itself, and of its connection with electricity; but when we attempt to apply theory to explain the actual condition of the earth progress is at once checked by difficulties, many of which have hitherto proved insuperable. We have no real knowledge of why the earth is a magnet, no real knowledge as to why its magnetic state is continually changing, and thus we are compelled to spend long periods of time in collecting facts, which, though their number and complication oppress us, are still insufficient to answer some of the simplest questions that an inquirer, approaching the subject for the first time, would be sure to ask. Terrestrial magnetism is in this respect in the same stage as that occupied by astronomy during the centuries in which the data were accumulated on which Kepler and Newton worked. We have a certain grasp of the facts, but have not yet found the thread of theory which binds them together.

And in one respect the magnetician is less favourably situated than was the astronomer. The rapid repetition of the principal astronomical events made it comparatively easy to discover the laws which those events obey; but, though some magnetic phenomena run through their courses in a day, a year, or a short period of years, the greatest change of all, that which causes the magnet to point now to the east and now to the west of the geographical north, has been studied for three hundred years and is still unfinished. It is a secular variation, of which the period, if definite period there be, must be measured by ages, and centuries may yet elapse before the first cycle which man has watched will be complete.

In spite of these difficulties attempts are continually being made to draw from the facts at our disposal some more definite information as to the causes of terrestrial magnetism; to foretell the future from the present; to trace the connection between the magnetic state of the earth and the constitution of the sun or of the earth itself; and I propose, therefore, to bring before you some of the theories and speculations which are now attracting the attention of those who take special interest in this science.

The fundamental fact, or rather series of facts, from which we have to begin our investigation is a knowledge of the magnetic state of the surface of the earth. To determine this, observations have for many years past been made at many different places, at sea and on land. The general result is a matter of common knowledge. The compass needle points approximately north and south, and dips from the horizontal towards the magnetic poles of the earth.

The first and simplest hypothesis that will serve as a rough approximate explanation of these facts, is that the earth itself is uniformly magnetised, or that there is at the centre of the earth a small but very powerful magnet by which the compass and the dipping needle are controlled.

If this suggestion were adequate, we should be compelled to assume that the axis of the magnet was inclined to the axis of the earth, for the magnetic and geographical poles do not coincide. It would further follow that at the magnetic poles, where the dipping needle is vertical, the magnetic force, which determines the position of the needle, would be of maximum intensity.

But here the simple hypothesis breaks down. The distribution of terrestrial magnetism is more complex than that which can be thus explained. It is true that there are two magnetic poles, but the directive force is not greatest where the needle is vertical. On the contrary there are in each hemisphere two other points, generally called magnetic foci, at which the force is a maximum.

It is thus evident that the magnetic system of the earth might be better represented by supposing that there are within it two magnets inclined both to each other and to the geographical axis, that the foci indicate the directions of these axes, and that the magnetic pole or point where the needle stands vertical is determined by their joint action. Mr. H. Wilde attempted to imitate the magnetic state of the earth by the aid of a duplex arrangement of this kind, but even this was insufficient. He was compelled to supplement it by covering with thin sheets of iron those portions of the globe which correspond to the oceans, and with this modification he succeeded in making a capital magnetic model of the earth.

For the moment, however, I will not follow up the line of inquiry thus suggested, but will only draw attention to the fact that, in spite of all these complications, mathematical analysis supplies us with the means of answering certain questions as to the magnetic constitution of the earth, without the aid of a clear mental picture of the causes to which that magnetic state is due. Whether there be one or more independent magnetic systems within the globe, whether some portions are more magnetic than others, are points upon which at present we have but little information, but there are a few facts from which we can argue with the knowledge that the foundations of our investigation are secure.

Magnetic forces can be produced only by magnetised matter, or by electric currents, and these may either exist within the globe or be external to its surface. Some of the currents, however, may be both internal and external in the sense that their circuits pass partly through the rocks and partly through the air, and that at certain points they traverse the surface from earth to air or from air to earth. Thus the first important question with which the investigator is confronted is: Are the forces which act upon the compass produced within or without the globe? and, if the magnetic forces are in part due to electric currents, are all these currents wholly internal or wholly external, or do some of them flow in part within and in part without the earth?

With regard to the first inquiry, the great mathematician Gauss furnished us with a method by which, if our knowledge of the magnetic state of the surface of the earth is sufficiently

[1] The "Rede Lecture" delivered in the Senate House, Cambridge, on June 9, by Prof. A. W. Rücker, F.R.S.

accurate and extensive, we can determine the relative proportions of those parts of the force which are due to causes wholly external or internal respectively. It is only lately that a further attempt has been made to discover whether, in addition to these, currents from earth to air and from air to earth also exist. The credit of this attempt is due to Dr. A. Schmidt, who, taking the most recent and the most accurate facts at his disposal, deduced from them the conclusion that about one-fortieth part of the magnetic force is due to causes wholly external to the earth, and that a slightly larger fraction is produced by vertical currents; the origin of the remaining thirty-eight fortieths being traced to internal causes only.

And now it becomes necessary to say a few words as to the method by which the vertical earth-air currents may be detected. If we could perform the impossible operation of severing the north pole of a magnet from the remainder without immediately producing poles of the opposite kind in the broken fragments, the isolated pole thus manufactured would be urged northwards by the magnetic forces which are in play near the surface of the earth. If therefore a traveller were to carry such a pole with him, he would be assisted when going northwards, retarded when returning to the south. If the tour ended at the starting-point, the advantage gained when moving in one direction would in general be exactly compensated by the disadvantage of being compelled to oppose the magnetic forces during the remainder of the journey.

To this rule there is one exception. If the migrations of the magnetic pole carried it round an electrical current, so that its course passed through the circuit in which the current flows, as a thread might pass through a ring, and if the route finally led back to the starting-point without again passing through the circuit of the current, the exact equilibrium of loss and gain would be destroyed, and when the journey was over the wandering pole would either have added to or drawn upon any store of energy which it might at first have possessed.

Whether the result would be a loss or a gain would depend upon the direction in which the journey was performed relatively to the direction of the current. On this point it is unnecessary to dwell. Suffice it to say that if the amount of the loss or gain experienced by a given pole is known, the magnitude and direction of the current, whose circuit had been traversed, can be calculated. The result would not be affected by whether the current flowed from all parts of the district which the path of the pole had encircled, or was confined to a few points only; the total flow would be registered without reference to how it was distributed. If some of the currents flowed in opposite directions the excess of one set over the other would be measured.

If now a current passes at a certain point from earth to air it must return from air to earth elsewhere, completing the circuit through the soil. The course of the unburied portion may be regarded as an aerial arch, and from what has been said it will be evident that if a magnetic pole were carried round a leg of this arch the circuit of the current would be pierced, and the total upward or downward flow would be determined. The experiment, as thus described, is impossible, but, by an appropriate method, we can determine the force which would be exerted at any point on the detached north pole of a magnet of given strength, and, if this be known for a sufficient number of points on the path, we can calculate what the result would be if the imaginary conditions of the journey could be realised.

The calculations of Dr. Schmidt as to the existence of earth-air currents were based upon this principle, and were applied to the earth as a whole. Their general accuracy has been confirmed by Dr. Bauer, who supposed the hypothetical isolated magnetic pole to be carried along lines of latitude right round the earth. If, for instance, the journey were made along latitude 51½°, beginning and ending at London, the resulting work would show the total amount of the currents which traverse the northern portions of the Northern Hemisphere between that latitude and the geographical pole. If the same operation were repeated, say on latitude 45°, a similar result would be obtained, and the difference between the two would give the average flow of the currents which traverse the surface of the earth between these two latitudes.

Of course, it must be remembered that by such a calculation we can only arrive at a mean result. If, for instance, we had proved that between these latitudes there was, on the whole, an upward current, it would by no means follow that at all points on the vast surface included between the selected boundaries the currents were flowing from below to above. The meaning of the result would be that, within the region considered, the upward were stronger than the downward currents, and that, if the excess were uniformly distributed over the whole of the surface to which the calculation applied, an average current of such and such a magnitude would be produced.

Turning from the method of detecting the vertical currents to the question as to whether they exist, there are, apart from the calculations of Schmidt and Bauer, some experimental and theoretical reasons which support an affirmative answer. We know that earth currents traverse the soil beneath us. The Aurora is evidence of electrical discharge in the atmosphere. It is conceivable that there are cross connections between these two systems. Again, if the immediate surroundings of the earth are electrically conducting, the mere rotation of the huge magnetic mass of the earth itself would cause the production of currents which at some points would flow out of, and at others would flow into the surface. The late Prof. Hertz calculated the forms of the paths of such currents for the case of a uniformly magnetised sphere rotating about its magnetic axis, and, though the fact that the magnetism of the earth is irregularly distributed forbids us to apply his calculation directly to the globe, yet the principle holds good, though the distribution of the currents would be more complex. Dr. Bauer has deduced from the calculations already referred to the average direction of flow between different latitudes.

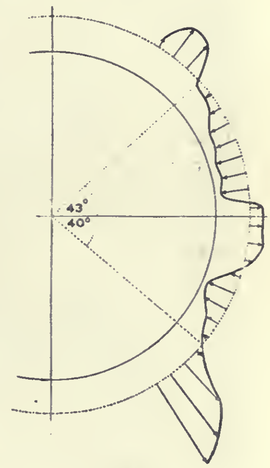

FIG. 1.

The result is shown in Fig. 1. The directions and magnitudes of the supposed vertical currents are indicated by arrows, and points at which there are no such currents occur at lat. 43° N. and 40' S.

Up to this point, therefore, the argument seems all in favour of the actual existence of currents from earth to air, but the results of calculations such as these must be accepted with very great caution. Our knowledge of the magnetic state of the earth is very imperfect; we know but little of the oceans as compared with the land, and of the land but little of the less civilised regions. Whatever be the lines of latitude chosen they must pass over sea, or desert, or both; and if the assumptions made as to the magnetic condiions of these regions are incorrect, it may be that the results are due not to the physical existence of the currents, but to the inaccuracy of the data to which the formulæ were applied.

It therefore becomes important to check such large scale calculations by others which depend only on the comparatively small areas which have been minutely studied.

In 1895, Dr. Carlheim-Gyllenskiöld applied the test for the existence of vertical currents to Sweden, for which comparatively numerous observations could be utilised. The conclusion at which he arrived was that there was no evidence for the existence of the currents, except in those parts of the country where the data were so untrustworthy as to make any conclusion valueless.

In 1896 similar calculations were made for this country. Dr. Thorpe and I have recently completed a magnetic survey of the United Kingdom which is, I believe, the most complete of any which has hitherto been made of an equally large area. All our observations were made within a few years, and, therefore, the corrections for secular change were comparatively unimportant.

The survey was divided into two parts, in one of which we depicted the magnetic state of the kingdom in 1886; while the other part was devoted to a similar investigation for the epoch 1891. We were thus able to compare the results obtained at two periods, separated by a few years only, and by their concordance or disagreement to judge of the value of our conclusions. As these appear to be of some importance with regard to the question we are now discussing, I have recently repeated the calculations in a somewhat different way, and have determined the average value of the currents flowing through all the districts

in the United Kingdom which are bounded by lines of latitude and longitude corresponding to whole degrees.

Thus, if starting on the meridian of Greenwich a traveller were to go due north from lat. 51° to 52°, that is from mid-Sussex to the north of Hertfordshire, then were to go due west until long. 1° W. was reached near Buckingham, thence due south along long. 1°, until when near Petersfield he turned homewards due east along lat. 51°, his route would include an area of, in round numbers, 2800 square miles, or of about 7000 square kilometres. In each such circuit the average current expressed in hundredths of an ampere per square kilometre has been determined, and the results are shown on maps both for 1886 and for 1891.

These maps are given in Fig. 2, A and B. The numbers indicate the average flow in hundredths of an ampere per square kilometre. The figures are underlined where the flow of the current is from above to below. In other cases the direction is upwards.

Fig. 2, A, shows the result for January 1, 1886, deduced from the 200 stations which were then available. In Fig. 2, B, all the facts obtained in the two surveys are worked up to a final result for the date January 1, 1891.

If we compare the two maps thus obtained from the two surveys, the conclusions arrived at are, in some respects, not very different. In both the larger currents occur near the boundaries of the land area to which the observations were necessarily confined. If the maps are to be trusted, the largest currents exist in the extreme north of Scotland, in the east of England, and in the far west of Ireland. It is also in favour of the trustworthiness of the results that in both cases the upward currents occur in the same parts of the kingdom. The figures indicate that the currents flow upwards in the far north, in the west and south, while in the midlands and the east the general tendency is from above to below.

But in spite of this apparent agreement, I am very doubtful whether these conclusions can be trusted. In the first place the currents are very minute. The whole flow of electricity passing through an area of 2800 square miles is less than that concentrated by Prof. Moissan in a few square inches within an electric furnace. The forces to be measured are so small that they must be seriously affected by the inevitable errors of observation and reduction.

Again, the observations which were made at nearly 900 places scattered all over the kingdom, are affected by local disturbances, due to quite other causes than those we are now discussing, and the magnetic state of the whole area, such as it would be if these disturbances were removed, can only be deduced by an elaborate system of averaging the results obtained at different places. This process of taking means is least accurate near the boundaries of the survey, and thus the larger currents which are indicated near the shores of our islands have probably no real physical existence, but are due only to the relative uncertainty of our knowledge of the magnetic state of the particular localities in which they appear to flow. From this point of view, therefore, it appears to be unsafe to trust to any particular figure, and that a better result will be obtained if we deal with larger areas and content ourselves with taking the mean of all the currents which appear to flow within them through the surface of the earth.

FIG. 2, A.

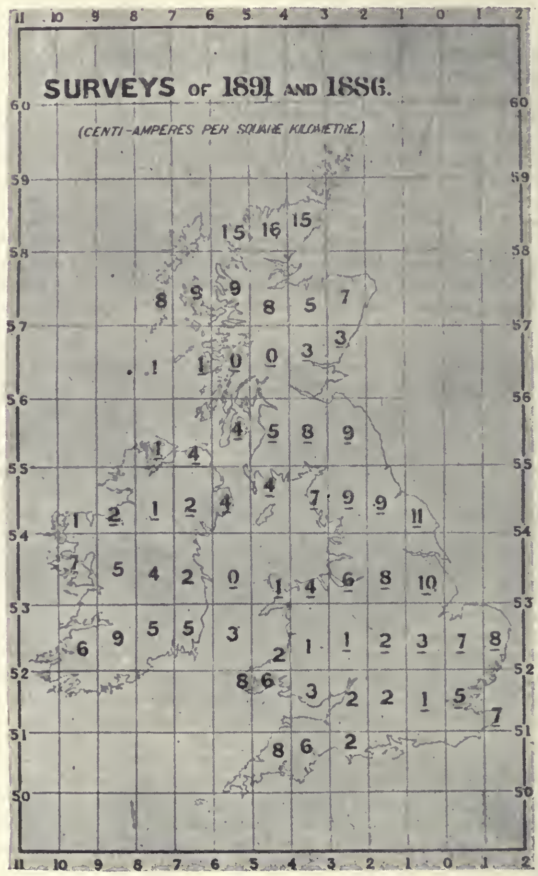

FIG. 2, B.

Adopting this plan, the general conclusions to be drawn from the two maps are very nearly identical. If for the moment we neglect the question as to whether the currents are flowing up or down, their average magnitude in any considerable area in the United Kingdom is about five-hundredths of an ampere per

square kilometre. If, however, we take account, as we are bound to do, of the difference of direction, treating those which flow upwards as positive and those which flow down as negative, the result would show that the mean current in the United Kingdom is about five-thousandths of an ampere per square kilometre. Of course, if we deal with considerable but smaller areas, the precise value obtained depends upon the district chosen, but this does not affect the conclusion to any important extent. Thus, for the reason I have already given, it is probable that our knowledge of the magnetic state of the central districts is better than our information as to the borders, and if we confine ourselves to the centre of the kingdom, we find that the average current is downwards in both cases, and that in 1886 it was apparently a little larger, and in 1891 a little less than one-hundredth of an ampere per square kilometre.

Even these concordant conclusions are rendered more doubtful if the two completely independent sets of results obtained by means of the two surveys for 1886 to 1891, respectively, are reduced to the same date. It is true that the magnitudes of the calculated currents are larger than those shown in the map given above, but on the whole they are so opposed in direction that the comparison compels us to reject the hypothesis of their physical reality.

I therefore feel justified in asserting that no evidence that can be relied upon points to the existence of any flow of electric currents through the surface of the British Isles, whether from below to above or from above to below. The quantities are so minute that if they existed they could barely be measured, and the results are too discordant to command assent.

Since the survey of the United Kingdom was completed, my friend Dr. Van Rijckevorsel has made a minute magnetic survey of Holland. In the case of so small a district it is more difficult to eliminate the effects of local disturbances than when the area to be dealt with is larger, and thus I doubt whether conclusions as to the flow of electrical currents drawn from Holland alone could be regarded as trustworthy. Taking them, however, for what they are worth, they indicate an upward current of about one-tenth of an ampere per square kilometre for that country. All these quantities are less than the currents which Dr. Schmidt's calculations demand. In the neighbourhood of the United Kingdom the flow should, according to his calculations, be upwards and the magnitude about fifteen-hundredths of an ampere per square kilometre. This is approached by the flow in Holland, but is from ten to twenty times greater than the average obtained over large areas in the United Kingdom.

So far, then, the question as to whether such currents really exist appears to be doubtful. The calculations of Schmidt and Bauer lead to the conclusion that when the world as a whole is investigated the answer is affirmative, but all the more accurate investigations which have hitherto been made in small areas combine to prove either that the currents do not exist, or that they are less than Dr. Schmidt's theory demands. This fact, taken by itself, is not conclusive, as Sweden, the United Kingdom, and Holland are all in the west of Europe, and it might well be that this happened to be a district in which the currents were exceptionally small; but, on the other hand, the doubt thus raised is formidable. Dr. von Bezold has recently stated to the Berlin Academy that Dr. Schmidt himself must now be added to the list of doubters; and von Bezold confirms this caution by figures which lead him to the conclusion that in all probability the results obtained from calculations which embrace the whole globe are due rather to the want of accuracy of our knowledge than of the physical reality of currents from earth to air. I should myself be sorry to pronounce a final opinion, but I must confess that I seriously doubt whether the horizontal magnetic force has been determined with adequate accuracy at a sufficient number of places in the vast regions which are covered with the sea to enable us to draw any final conclusion from areas which include them, and I certainly consider that the balance of evidence is at present opposed to the physical reality of the currents. Before we can accept the opposite proposition some evidence must be produced based on surveys as complete as those of England and Holland. Before long we shall probably have full information as to France and Maryland, and it is possible that one or other of these may furnish positive evidence sufficient to outweigh the negative results which have hitherto been obtained.

(*To be continued.*)

A PROPOSED SWEDISH EXPEDITION TO THE ARCTIC REGIONS.

A YEAR since, Dr. A. G. Nathorst, of Stockholm, read a paper before the Swedish Society for Anthropology and Geology, entitled "Återblick på Polarforskningens närvarende Ställning samt Förslag till en Svensk Polarexpedition" (a review of the present position of Polar investigation, with a project for a Swedish Polar expedition), which has since been published in *Ymer* (Årgång 1896, Heft 4, pp. 267–286), the journal of the Society. At the time of reading the paper, there seemed but little probability of a near realisation of the projected scheme; but, during the present year, the King of Sweden and certain wealthy merchants of Stockholm and Gothenburg have generously come forward and provided the funds necessary for carrying it out, and Dr. Nathorst, who will act as the scientific leader of the expedition, is now engaged in preparations for a start next year (1898).

As the result of Nansen's voyage, Dr. Nathorst thinks that there is but little probability of the discovery of fresh land areas in the vicinity of the Pole, and that the aim of future expeditions to the Arctic regions should be a thorough scientific investigation of those lands, of which at present but little is known beyond the fact of their existence. Under this head may be mentioned the west coast of Ellesmere Land and Grinnell Land and the neighbouring islands; also the shores of Jones Sound, in Arctic America. Further, large tracts of the north-eastern and north-western coasts of Greenland remain to be examined, in spite of the admirable work of the Danish, Austrian, and other exploring expeditions. But it is with Spitsbergen and the region east of it that previous Polar explorations on the part of Sweden have been most closely connected; and though no fewer than twelve different Swedish expeditions, led by such men as Torell, Nordenskiöld, Nathorst, de Geer, and others, have visited this region since 1858, and that it has been the field of work for expeditions from other countries as well, the most recent being that under Sir Martin Conway in 1896, it yet offers, in Nathorst's opinion, a rich harvest for scientific investigation.

The west coast of Spitsbergen is now fairly well known, but owing to the ice coming from the east and blockading the eastern coasts of the island, nothing has as as yet been ascertained of their geological structure. The same obstacle has also prevented observations on Stans Foreland (Edge Island), Barentz Land, North East Land, Kung Karls Land, and Ny Island; but it is probable, that given favourable conditions of the ice, a steam vessel would be able to approach sufficiently near these islands to allow of their geology at least to be made out. The exploration of these lands between Spitsbergen and Franz Josef Land is the main object of the expedition; but should this be frustrated by the prevalence of the ice, the research work would be carried on in Spitsbergen itself, and more particularly a study would be made of the raised shell-banks and terraces, evidencing a comparatively recent elevation of the land, and of the remarkable quaternary deposits which show that the climate of the island, for a certain interval after the Ice age, was warmer than at the present time. Promising botanical results might be also expected from an examination of the valleys extending from the heads of the fiords, as, for example, those in Sassen Bay, Kol Bay, and Van Mijens Bay.

A stout vessel of from 350 to 400 tons, and a crew of thirteen men, would, in Nathorst's opinion, be most suitable for the undertaking; and the scientific staff would consist of a geologist, a botanist, two zoologists, one hydrographer and meteorologist, and one for cartography and photography. It is not intended to over-winter in the Arctic regions, but the vessel would be provisioned for a year, in case of accidents. The estimated cost of the expedition is about 4000*l*. It is proposed to reach Spitsbergen in the beginning of June, and work there until the middle of August, when it is hoped the ice will allow Kung Karls Land and the other islands near it to be examined.

THE USE OF KITES IN WEATHER PREDICTION.

THE systematic exploration of the upper air by means of kites is referred to by Prof. Cleveland Abbe in the *Monthly Weather Review*, at the end of a long article upon the experiments made previous to 1893. It is pointed out that at that time the Malay kite and the free balloon were merely

looked upon as the means of occasionally obtaining isolated items of information from the upper regions; the world had not then awakened to the possibility of the work inaugurated by Prof. Moore in July 1895, which looks to the compilation of a daily map of simultaneous observations high above the earth's surface and over a large portion of the United States, for study in connection with the map of surface conditions. Observations of the air at a single station can have but little value compared with the international balloon work of Europe, or the extended national kite work of the U.S. Weather Bureau.

In an address at Toronto, before the British Association, Prof. Moore is reported by the *Review* to have said:

"For twenty-seven years the forecasters of the Weather Bureau have studied the inception, development, and progression of these different classes of atmospheric disturbances. From a knowledge personally gained by many years' service as an official forecaster, I do not hesitate to express the opinion that we have long since reached the highest degree of accuracy in the making of forecasts possible to be attained with surface readings. It is patent that we are extremely ignorant of the mechanics of the storm; of the operations of those vast yet subtle forces in free air which give inception to the disturbance, and which supply the energy necessary to continue the same. Long having realised this, I determined at once, on coming to the control of the United States Weather Bureau, to systematically attack the problem of upper-air exploration, with the hope ultimately of being able to construct a daily synoptic weather chart from simultaneous readings taken in free air at an altitude of not less than one mile above the earth. It appeared to me that all previous plans for investigating the upper air, by means of free and uncontrollable balloons, by observers in balloons, or by isolated kite stations or mountain observatories, were of little value in getting the information absolutely necessary to the improvement of our methods of forecasting. Simultaneous observations, at a uniform high level, from many co-operating kite stations, was the fundamental feature of the plan that I inaugurated for the prosecution of this important investigation.

"Prof. Marvin was assigned to the difficult task of devising appliances and making instruments, and I am pleased to say that we have improved on kite flying to such an extent that apparatus is now easily sent up to a height of one mile in only a moderate wind. We have made an automatic instrument that, while weighing less than two pounds, will record temperature, pressure, humidity, and wind velocity. By January next we expect to have not less than twenty stations placed between the Rocky Mountains and the Atlantic Ocean taking daily readings at an elevation of one mile or more.

"We shall then construct a chart from the high-level readings obtained at these twenty stations, and study the same in connection with the surface chart made at the same moment. As we shall thus be able to map out not only, as now, the horizontal gradients for the lower surface conditions, but in addition the simultaneous gradients for the upper level, and, what is of still more importance, shall be able to deduce from these, for any section of the atmosphere, the simultaneous vertical gradients of temperature, humidity, pressure, and wind velocity, we may confidently hope to better understand the development of storms and cold waves, and eventually improve the forecasts of their future course, extent, and rate of movement. It will be a fascinating study to note the progress of cold waves at the upper and lower levels, and to determine whether the changes in temperature do not first begin above. I am anxious to know the difference in temperature between the surface and the upper stratum in the four quadrants of the cyclone, and also of the anti-cyclone, especially when the storm or cold-wave conditions are intense. The vertical distribution of temperature in the several quadrants may give a clue to the future direction of movement of the disturbance."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MISS EMILY PENROSE, principal of Bedford College, London, has been appointed principal of the Royal Holloway College, Egham.

MR. WM. H. SAGE and Dean Sage have presented to Cornell University the large residence of the late Mr. Henry W. Sage, at Ithaca, for a students' hospital, and will equip it and endow it with 100,000 dols. The residence is valued at 80,000 dols.

THE following resolution has been unanimously passed by the lecturers and teachers in the medical school of Guy's Hospital: "That the medical school of Guy's Hospital earnestly request Her Majesty's Government to reintroduce into Parliament the London University Commission Bill of 1897, and to pass it into law during the ensuing Session."

AMONG the institutions created during the last half-century for the promotion of scientific research and education, the Sheffield Scientific School of Yale College, New Haven, holds an honourable place. A review of the foundation of the School, and of the work of the distinguished investigators who have been connected with it, was given in a discourse delivered by President Gilman at the semi-centennial anniversary recently held. It was in 1847 that Profs. Silliman and Norton opened a laboratory on the College grounds for the purpose of practical instruction in the applications of science to the arts and agriculture. Thus was born the Sheffield Scientific School of Yale University. At first chemistry was alone; engineering soon found a place; mathematics, physics and astronomy joined the oligarchy; in due time, mineralogy, geology, physical geography, zoology, botany and physiology found a welcome; modern languages and literature, history and economics, became strong allies. While this evolution was going on, not a word was spoken in disparagement of classical culture, nor a word of religious controversy. From the beginning onwards the institution has been the department of a University which never suffered its love of letters to blind its eyes to the value of science. The School largely owes its success to its association with the fame, the fortune, and the followers of a great *alma mater.* Substantial advantages were bestowed by the mother upon her offspring; and the present high position which the School occupies shows that the child has deserved the encouragement it has received.

A MEETING was held at the University of London on Tuesday afternoon, the Chancellor (Lord Herschell) presiding, to discuss the proposed legislation on the University of London question. The *Times* reports that there were present, besides the Vice-Chancellor (Sir Henry Roscoe), representatives of the Corporation of the City, the Technical Education Board of the London County Council, the Royal Colleges of Physicians and Surgeons, the various medical schools, University College, King's College, Bedford College, the Royal College of Science, and the City and Guilds of London Institute. The Chancellor invited expression of opinion on the London University Commission Bill which the Government propose to reintroduce early in the Session. He said that the Bill embodied the compromise between the various parties hitherto in conflict, and that it was to receive the support of the Senate, as also of both parties in Convocation. The Chancellor further explained why no proposal for any new charter was within the range of practical politics, reconstitution at the hands of a statutory commission being the only remaining course. He therefore urged the acceptance of the compromise. Many of those present spoke in favour of the scheme, and urged that a deputation should wait upon the Vice-President of Council at an early date. The only objection came from one of the smaller medical schools, which declared its preference for the creation of a second University in London. The feeling of the conference was, however, entirely in favour of the reconstruction of the existing University. A deputation to the Government will be appointed as suggested to urge the passing of the Bill.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, November 1897.—The number opens with an account, by Prof. Osgood, of the proceedings at the International Congress of Mathematicians held at Zürich in August last. The transactions of the Congress, which was attended by about two hundred mathematicians, together with the papers read, or presented, are to be published in full.—Prof. J. McMahon performs a like work for the Detroit meeting of the American Association for the Advancement of Science. An analysis of the twenty-one papers presented to the Section is given. One of these communications was an account of stereoscopic views of spherical catenaries and gyroscopic curves by Prof. Greenhill, who was present at the meeting, and to whom the Section "is also indebted for instructive remarks made in connection with many of the other papers." Then follow five papers read before the American Mathematical

Society, viz. before the Chicago Section (April 24, 1897): Quaternions as members of four-dimensional space, by Prof. A. S. Hathaway. Note on the invariants of n points, by Dr. E. O. Lovett, is another communication which was made at the same meeting.—Dr. Lovett contributes also a note on the fundamental theorems of Lie's theory of Continuous Groups (October 30). The object of the note is to call attention to a misapprehension, if not an error, in a paper, by J. E. Campbell, on a law of combination of operators bearing on the theory of continuous transformation groups, read at the March 11 meeting of the London Mathematical Society (*Proc.*, vol. xxviii. pp. 381-390). The fourth paper is one read at the Toronto meeting, August 16. It is an interesting short note by Prof. T. F Holgate, and is entitled, "A geometrical locus connected with a system of coaxial circles." The writer's object is to find the locus of points through which three lines can be drawn tangential to three circles of a coaxial system in pairs.—Condition that the line common to $n-1$ planes in an n space may pierce a given quadric surface in the same space, by Dr. V. Snyder, was read at the Detroit meeting mentioned above. The note is a generalisation of a proof recently given by the author (criteria for nodes in Dupin's cyclides) of the geometric significance of a certain determinant.—Dr. E. W. Brown gives a valuable analysis of Prof. H. Lamb's Hydrodynamics. Of this the reviewer writes: "The author is to be congratulated on the completion of a task which will earn him the gratitude of all those who are now, or may in the future be, interested in Hydrodynamics.—In the Notes are particulars of the British Association meeting at Toronto, in so far as it concerned mathematicians. —Other matters are a list of the mathematical courses for the winter semester (1897-98) in the Universities of Göttingen, Leipzig, Munich, Vienna and Strassburg.

IN the *Meteorologische Zeitschrift* for November, Dr. J. Hann gives the daily range of the meteorological elements at Cairo, deduced from the observations of the five years 1891-5, as published in the *Résumé Mensuel* of the observatory at Abbassieh. These values are of some interest, as Dr. Hann states that the monthly means contained in the tables give for the first time the true daily means for Cairo. The barometric range exhibits the small amplitudes for the latitude that have been noticed in other parts of the Mediterranean. The night minimum does not appear to fall below the daily mean throughout the year. The range of temperature shows no special peculiarities; it is greatest in June, and is greater in the dry spring than in the damp autumn. The daily range of wind force is noteworthy, especially during spring and autumn; during the year there is only a very slight variation at night-time, but in the afternoon there is a great increase in the force from winter to spring, and from summer to autumn. During the winter half-year the nights are clear, while cloud prevails at the middle part of the day; in the summer the morning hours are cloudiest, but from about noon the sky is almost cloudless. The influence of the overflow of the Nile in the autumn naturally affects the range of humidity.

IN the *Journal of Botany* for November and December, Mr. F. Townsend completes his monograph of the British forms of *Euphrasia*, of which he makes fourteen "species" founded on von Wettstein's monograph of the genus. It is accompanied by seven plates illustrating the habit of each "species," and details of the form of the flowers and leaves.—In a paper on "New and Critical Marine Algæ," Mr. E. A. L. Batters describes a number of species new to science, together with a new genus, of Florideæ, *Porphyrodiscus*, from Berwick, with the crustaceous habit of *Hildenbrandtia*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 25.—"On certain Media for the Cultivation of the Bacillus of Tubercle."[1] By Dr. Arthur Ransome, F.R.S.

The following conclusions had been drawn from previous experiments:—

(1) That finely divided tuberculous matter, such as pure cultures of the bacillus, or tuberculous matter derived from sputum, in daylight and in free currents of air is rapidly deprived of virulence;

(2) That even in the dark, although the action is retarded, fresh air has still some disinfecting influence; and

(3) That in the absence of air, or in confined air, the bacillus retains its power for long periods of time.

These observations afforded an explanation of the immunity of certain places, and the danger of infection in others. They show that where tuberculous sputum is exposed to sufficient light and air, to deprive it of virulence before it can be dried up and powdered into dust, no danger of infection need be dreaded. It would appear further, from this research and others, that it is only when there is sufficient organic material in the air, derived from impure ground air, or from the reek of human bodies, that the tubercle bacillus can retain its existence and its virulent power.

But, in addition to the above-mentioned researches, it seemed desirable that an attempt should be made to ascertain what part was played respectively by the several forms of organic impurity that are present in insanitary dwellings. It was determined, therefore, to collect the aqueous vapours arising from the ground, or from human bodies, and to submit these products to the test of trying whether they would serve as cultivating media for the bacillus of tubercle.

By means of a simple freezing mixture of ice and salt it was easy to condense the aqueous vapour, both of the breath and that coming from ground air.

Some evidence was obtained with simple glycerine agar that the organic fluids facilitated cultivation to some extent. With the organic fluids there were only two failures, and growth was fairly rapid.

In the next series of trials, it was decided to use as the material bases some non-nitrogenous substance, and at length it was determined to use a particularly pure "filter-paper."

Some degree of success was attained in twelve out of fifteen specimens of the organic fluids.

The degree of growth was also much the same as in the previous series, though perhaps slightly less vigorous.

It was now determined to try to do without the help of the glycerine, which, as is well known, so greatly assists the ordinary cultivations of the bacillus. Accordingly, four tubes with simple filter-paper as the supporting medium, and condensed fluids, from the breath of a healthy person, and from that of a phthisical patient, as nutrient fluids, were inoculated, and no glycerine was added. In these tubes the same cultivation was used as in the previous experiments.

Shortly afterwards, two similar tubes with fluid from healthy breath alone, but with 5 per cent. of glycerine, were sown with the same cultivation, and were left at the ordinary temperature of the laboratory, about 21° C.

All of the former group took on active growth within four weeks, and one of the latter. In other words, it was proved that pure filter-paper, moistened with these condensed fluids, alone would suffice to nourish and promote the growth of the bacillus, and, further, that this growth would take place at ordinary temperatures. It may hence be concluded that when this organic fluid is present in ordinary dwellings, the bacillus may grow at the temperature of living rooms as well as at the temperature of 35° C.

Two sets of tubes were then prepared of condensed vapour from breath, and from ground air from a pure sandy soil. No glycerine was added; but for the solid medium, in some instances, the pure filter-paper was employed; in others, an ordinary lining paper, containing a little size, but carefully sterilised, was used.

Some of these were placed in the incubator at a temperature of 37° C., others were left in the dark at the ordinary temperature of the laboratory.

In many of the tubes a free growth was observed as early as the end of the first fortnight.

Out of the total number in this series of 37, in thirty six instances there was free growth on the medium employed, on both kinds of paper, and all kinds of condensed fluid. Eleven of them were grown at a temperature of about 20° C. In only one instance was there complete failure (vapour from healthy breath).

The bearing of these researches upon the subject of the prophylaxis against tuberculosis seems to be of some importance.

They prove that any one of the various organically charged vapours, whether coming from healthy or from diseased lungs,

[1] By permission of the Royal College of Physicians, this research, which forms a portion of the Weber-Parkes prize essay, is communicated to the Royal Society before publication. The cost of the inquiry is defrayed by the Thruston prize, presented to the author this year by Gonville and Caius College, Cambridge.

from the air of cellars, or from comparatively pure ground, forms an excellent cultivating medium for the bacillus of tubercle when kept away from the disinfecting influence of air and light.

This power of promoting its growth is particularly manifest when the supporting substance is common wall-paper, though it is quite apparent when very pure filter-paper is used.

It is further proved that, on these substances, the growth of the bacillus may take place at the ordinary temperatures of dwelling-rooms; and, hence, that there is no safety against the increase of the organism in ordinary living-rooms in which active tuberculous dust is present, and in which the natural disinfectants of the bacillus, fresh air and light, are not present in sufficient amount to destroy their virulence.

Physical Society, December 10.—Mr. Shelford Bidwell, President, in the chair.—Mr. Albert Campbell exhibited: (1) An experiment to illustrate alternate exchange of kinetic energy. Two brass spheres, each about one inch diameter, are suspended from the same point by equal wires. One of them is then thrown so as to describe a circular orbit. The second sphere, starting from rest, gradually takes up motion from the first sphere, and in turn describes a circular orbit. The first now comes to rest, and the reverse process takes place. This alternating action repeats itself until all the energy is lost in the wires. (2) An experiment to illustrate the low heat-conductivity of glass, and the expansion of glass by heat. A long tube is clamped at the lower end, in a vertical position. One side of it is then heated with the flame of a Bunsen burner, and the glass is observed to bend, moving over a fixed mark near the top of the tube. When the flame is withdrawn, the first position is quickly regained. Mr. Campbell then read a paper on "Temperature compensators for standard cells." Some account of the methods adopted by the author has already been published, he now describes the apparatus. The first compensating arrangement (3) can be used for keeping the potential-difference between two points of a conducting system constant at all room-temperatures. Or it can be adapted to modify the voltage of a standard cell to some convenient whole number. This arrangement (3) resembles a Wheatstone's bridge with the galvanometer-branch removed. One pair of opposite arms is of copper, the other pair is of manganin. The bridge-battery is a Leclanché cell; this supplies the auxiliary voltage, which is utilised at the two galvanometer-points of the bridge, and is there applied in series with the standard cell. In an alternative method, suggested by Mr. C. Crawley, only one of the four arms is made of copper. The second compensating arrangement (4) is intended to maintain constant potential between two points, at all room-temperatures. For this purpose, two wires, a and b, are connected in parallel. One of them, a, is all of manganin, the other, b, is partly copper and partly manganin. Constant *current* is applied at the ends of a and b. The various resistances are chosen so as to give constant difference of potential between the ends of the manganin portion of b. By this method the potential-difference can be maintained to within 1 in 2000. Mr. Swinburne said that twelve or thirteen years ago he had given a good deal of thought to compensation by wires of different temperature-coefficients. The first thing he tried was a Wheatstone's bridge. This was compensated by making the bridge-arms of wires whose temperature-coefficients differed—as, for instance, platinoid and copper. He then applied the same principle to the compensation of standard cells, using a potentiometer method that gave direct readings, and to the compensation of voltmeters and watt-meters. These results were published between 1885 and 1890, in the electrical journals. He believed that Mr. Evershed had also developed this idea, by putting "back" turns on voltmeters, and by other differential devices. The details of Mr. Campbell's apparatus had a few points of special interest. The way in which he connected up the bridge (3) seemed particularly worthy of notice. Prof. Ayrton asked whether thermo-electric effects produced difficulty in the compounded arrangement. Mr. Campbell said the system was symmetrical, and the thermal currents were consequently neutralised. Mr. Appleyard, referring to experiment (2), said it was identical with one that had been shown for the past eight years at lectures at Cooper's Hill College. It was specially of interest as illustrating the deflection that occurs with girders and bridges when exposed on one side to sunshine. —Mr. J. Rose-Innes read a mathematical paper on Lord Kelvin's absolute method of graduating a thermometer. Lord Kelvin has investigated the cooling effects exhibited by various gases in passing through a porous plug. He found that for any gas, kept at the same initial temperature, the cooling effects were proportional to the difference of pressure on the two sides of the plug. He also found that, for any one gas, the cooling effect per unit difference of pressure varies approximately as the inverse square of the absolute temperature. This rule holds very well in the case of air; it is not so satisfactory for carbonic acid; it fails for hydrogen. With hydrogen there is a *heating* effect that increases, if anything, when the temperature rises. Mr. Rose-Innes proposes an empirical formula, containing two disposable constants, α and β, characteristic of the gas in question. Denoting by T the absolute temperature, he finds that, very approximately, the cooling effect is given by the expression $(\alpha/T - \beta)$ This relation includes the three cases—air, hydrogen, carbonic acid—under one form, and thus enables them to be treated in one common investigation. Moreover, the differential equation concerned in the thermo-dynamic scale is thereby rendered more manageable; it leads to simpler algebraic results after integration. The paper discusses the thermo-dynamic correction for a constant-pressure gas-thermometer, and the correction for a constant-volume gas-thermometer; also an estimate of the absolute value of the freezing-point of water; the results obtained take, for the most part, a very simple shape, using the above expression for the cooling. Dr. S. P. Thompson said the empirical expression, $(\alpha/T - \beta)$, indicated that at some particular temperature the cooling effect vanished; that was a point suggestive of useful results if investigated by experiment. Mr. J. Walker read a communication from Mr. Baynes on the paper, and remarked upon the desirability of adopting two constants. He thought that further experiments should be made to discover how specific heat at constant temperature depends on temperature. The calculated values for hydrogen were too few to be taken as evidence of the validity of the rule. Mr. Rose-Innes, in reply, said that from what was known of hydrogen, it might be expected to behave at ordinary temperatures as air behaves at higher temperatures. His object was, if possible, to include in one formula the case of the three investigated gases. This was better than having a separate formula for each gas. Whether or not hydrogen was confirmatory with air and carbonic acid, might be considered as *sub judice*; it required further experimental data to test the formula in that case.—The President proposed a vote of thanks to the authors, and the meeting was adjourned until January 21, 1898.

Chemical Society, November 18.—Prof. Dewar, President, in the chair.—The following papers were read:—On the decomposition of camphoric acid by fusion with potash or soda, by A. W. Crossley and W. H. Perkin, jun. Camphoric acid, when fused with alkali, gives a mixture of a number of fatty acids with dihydrocamphoric acid, $C_{10}H_{18}O_4$, pseudocamphoric acid, $C_{10}H_{16}O_4$, and an acid of the composition $C_9H_{16}O_4$; the results are explained and constitutions assigned on the assumption that camphoric acid has the constitution,

$$\left.\begin{array}{l} CH_2 . CH\,(COOH) \\ | \\ C\,Me_2 . CMe(COOH) \end{array}\right> CH_2.$$

—Experiments on the synthesis of camphoric acid, by W. H. Bentley and W. H. Perkin, jun. The authors have prepared isobutylmethylhydroxyglutaric acid, $CHMe_2.CH_2.CH(COOH).CH_2.CMe(COOH)OH$, hoping that by loss of water it would give an acid of the constitution assigned in the previous paper to camphoric acid; by loss of water, however, a lactonic acid or its derivatives were usually obtained.—Synthesis of an isomeride of camphoronic acid, by S. B. Schryver.—The action of magnesium on cupric sulphate solution, by F. Clowes and R. M. Caven. When magnesium acts on copper sulphate solution, hydrogen, cuprous oxide, and copper are produced.—Properties and relationships of dihydroxytartaric acid, by H. J. H. Fenton. Dihydroxytartaric acid is readily prepared by oxidising dihydroxymaleic acid in aqueous solution; it gives a quantitative yield of tartronic acid on heating.—The molecular association of liquids and its influence on the osmotic pressure, by H. Crompton. The author shows that Planck and van Laar's demonstrations that association can have no effect on osmotic pressure are invalid owing to faulty reasoning.

Geological Society, December 1.—Dr. Henry Hicks, F.R.S., President, in the chair.—A revindication of the Llanberis unconformity, by the Rev. J. F. Blake. In a paper published in the *Quarterly Journal* of the Society for 1893, the

author of the present paper maintained that certain conglomerates and associated rocks occurring for some distance north east and south-west of Llanberis, which had hitherto been considered to lie below the workable slates of the Cambrian rocks of that area, were in reality unconformable deposits of later date than those slates. In the year 1894 a paper appeared in the same journal, in which the authors maintained that in no case which had been examined could any valid evidence be found in favour of the alleged unconformity, and that in one (on the north-east side of Llyn Padarn) which they supposed to afford the most satisfactory proof of it, the facts were wholly opposed to the notion. The present paper was a reply to these authors, in which their objections, founded on general considerations, on field observations, and on microscopic examination of rock-specimens, were discussed, and the author gave the results of further observations on the rocks of the district.—The geology of Lambay Island, Co. Dublin, by Messrs. C. I. Gardiner and S. H. Reynolds. The authors, who have previously described the neighbouring district of Portraine (*Quart. Journ.* Geol. Soc., December 1897), undertook an examination of this island, with the intention of comparing the rocks with those of Portraine, and of investigating the nature of the rock familiar to geologists under the name of "Lambay porphyry." The sedimentary rocks are similar to some of those of Portraine, and are of Middle or Upper Bala age. Associated with them are pyroclastic rocks and andesitic lava-flows, some of the lavas having flowed beneath the sea. The sediments and volcanic rocks were exposed to denudation, and a conglomerate composed of their fragments was accumulated round the volcano. The "Lambay porphyry," which has been determined as a diabase-porphyry by Dr. von Lasaulx, is partly intrusive in the other rocks, but has in places come to the surface as a lava-flow Petrographical descriptions of the various rocks were given by the authors.

Mathematical Society, December 9.—Prof. Elliott, F.R.S., President, in the chair.—Miss F. Hardcastle communicated a theorem concerning the special systems of point groups on a particular type of base curve.—Mr. Love, F.R.S., gave a sketch of a paper, by Prof. W. Burnside, F.R.S., on the straight line joining two given points.—Impromptu communications were made by Messrs. F. S. Macaulay, A. Berry, and E. T. Whittaker.

Entomological Society, December 1.—Mr. R. Trimen, F.R.S., President, in the chair.—Mr. Dudley Wright exhibited an aberration of *Argynnis euphrosyne*, in which the upperside was suffused with black, and the silver spots of the underside of the hindwings converted into streaks.—On behalf of Mr. W. H. Tuck, Mr. Tutt showed examples of *Metœcus paradoxus*, L., taken in nests of *Vespa vulgaris* near Bury St. Edmunds, together with some of the cells in which they were found. About a fifth of the nests examined were affected, some containing as many as twenty-four, twelve and eight examples of the beetle; the more usual number present was from two to four. The dates between which examples were taken in 1897 were from August 2 to October 1. According to Dr. Chapman the eggs were laid in the cracks of posts, &c., from which the wasps got the pulp to make their cells.—Combs were also exhibited from nests of *Vespa crabro* and *Vespa germanica*, in which Mr. Tuck had found larvæ of *Velleius dilatatus*, Fabr., which, however, he had been unable to rear.—The Rev. A. E. Eaton exhibited a specimen of the singular *Myodites subdipterus*, Fabr., taken by himself at Biskra, Algeria, and a near ally of *Metœcus*.—Mr. Blandford called attention to a new instance of the destructive propensities of *Dermestes vulpinus*, Fabr. He had received examples found at Hong-Kong among flags made of bunting, which were presumably injured, although no details had been forwarded. This form of injury was analogous with the damage to woodwork recorded by himself and others; it had nothing to do with the feeding-habits of the insect, but was committed by the larvæ in their search for shelter in which to pupate. Probably the flags had been stored at some period in the neighbourhood of infested leather goods, or dried provisions. The only other case of damage to textile fabrics by *Dermestes vulpinus* which he knew of occurred in connection with the case recorded by him (*Proc. Ent. Soc. Lond.*, 1890, p. xxxi); a blue handkerchief spotted with white, left in the infested building, was found next day to have all the white spots eaten out.—Mr. Champion communicated papers entitled "Notes on American and other Tingitidæ, with descriptions of two new genera and four species," and "A list of the Staphylinidæ collected by Mr. J. J. Walker, R.N., in the Straits of Gibraltar."

PARIS.

Academy of Sciences, December 6.—M. A. Chatin in the chair.—On the stability of the Eiffel tower, by M. Bassot. The paper is accompanied by four diagrams, showing the motion of the summit of the tower. The conclusion is drawn from these curves, that to verify by periodic observations any permanent displacement undergone by the summit, the measurements should be taken in the evening, two or three hours before sunset, as at that time the irregular movements are at a minimum.—On double integrals of the second species in the theory of algebraic surfaces, by M. Émile Picard.—The first modifications which occur in the fixed cells of the cornea, in the neighbourhood of wounds of that membrane, by M. L. Ranvier. A section is cut perpendicularly to the incisions made in the living animal, and gold staining applied until the fixed cells are nearly black. Those cells which have been cut by the knife at the end of twenty-four hours show budding prolongations by the edges of the wound. These phenomena exhibited by the cells of the cornea of the rabbit are of the same order as the extension by budding of the cylinder axes of cut nerve cells.—On the contamination of wells, by M. Duclaux. By an analytical study of the waters from the shallow wells of a village lately subject to a slight typhoid epidemic, it is shown that a comparatively simple chemical analysis suffices to distinguish between polluted and unpolluted wells, provided that the composition of the water of the district in a pure state is known. The bacteriological method of examination is looked upon as less trustworthy than the chemical method.—Actinometric observations made upon Mont Blanc, by MM. Crova and Hansky. The measurements were carried out in August and September, and were much interfered with by rain. At the summit the maximum value of the solar constant was 3·4, and it is suggested that under more favourable conditions this magnitude might be increased to 4·0.—Observations on the planet (DL) Charlois (1897, November 23) made at the Observatory of Toulouse (Brunner equatorial), by M. F. Rossard.—Application of the method of least squares to the detection of systematic errors, by M. Jean Mascart. A discussion of the conditions under which the application of the method of least squares becomes illusory.—On the approximation of functions of large numbers, by M. Maurice Hamy.—On associated pencils, by M. C. Guichard.—On the focal planes of a curve plane to one or several axes of symmetry, by M. P. H. Schoute.—On the existence of integrals in certain differential systems, by M. Riquier. Elliptical vibrations in fluids, by M. V. Crémieu.—The interference in air of two sound waves of different phases has been studied by observing the motion of a quartz fibre placed at the point of intersection of the waves.—On the dissociation and polymerisation of gases and vapours. Supposed dissociation of chlorine at high temperatures, by M. A. Leduc. The only evidence in favour of the dissociation of chlorine is one isolated observation of M. Crafts at 1400° C.—On the electric conductivity of discontinuous conducting substances, in relation to telegraphy without wires, by M. Édouard Branly.—On the transformation of the X-rays by metals, by M. G. Sagnac. If a bundle of X-rays is allowed to impinge upon a polished metallic surface, such as steel, or a mercury bath, there is no appreciable regular reflexion, but rays, termed by the author secondary rays, can be shown photographically or electrically to be diffused from the surfaces. These radiations show generally all the properties of the original X-rays, but the nature of the metal is not without influence, as the secondary rays from different metals can be distinguished by their unequal transmission by the same substance.—Some new facts observed in Crookes' tubes, by M. Virgilio Machado.—On the accidental causes of irreversibility in chemical reactions, by M. A. Colson. Two reactions are described in detail: the decomposition of normal phosphates by hydrochloric acid, and that of silver sulphate by hydrogen sulphide. In both cases secondary reactions intervene, which render the reversibility of the phenomena impossible.—On the existence of a cuprous sulphate, by M. A. Joannis (see p. 159).—On the elementary unity of the body called cerium, by MM. Wyrouboff and A. Verneuil. A criticism of the results of M. Boudouard, whose atomic weight determinations are stated to be affected both by impurities in his material, and inaccuracy in experimental work.—On aldehyde ammonia, by M. Marcel Delépine. Aldehyde ammonia, when left for three days in a vacuum over sulphuric acid, loses water, giving brilliant white crystals of a new base, ethylidene-imine, which analysis and cryoscopic estimations show to have the formula $(CH_3-CH=NH)_3$. A solution of

aldehyde-ammonia in absolute alcohol gives a crystallised picrate of the same base.—On a reaction peculiar to orthophenols, and on the derivatives of antimonylpyrocatechol, by M. H. Causse.—On the nature of the combinations of antipyrine with aldehydes, by M. G. Patein.—Physiological and therapeutic effects of spermine, by M. Alexander Pœhl. The effects of the alkaloid are uniform, and consist in accelerating the phenomena of oxidation, thus favouring the elimination in the form of harmless products of several poisonous organic secretions.—Disappearance of lead poisoning by the partial substitution of metastannic acid in the putty used in glass polishing, by M. L. Guéroult. The original putty contained 62 per cent. of lead; by the addition of metastannic acid the lead was reduced to 20 per cent. During the six years in which this modified powder has been used, there have been no symptoms of lead poisoning in any form, although, with the original putty, saturnine paralysis was frequent.—On some new colloidal substances, analogous to albuminoids, derived from a nucleo-albumin, by M. J. W. Pickering.—On the development of *Trombidion holosericeum*, by M. S. Jourdain.—Observations on the *Rougets*, by M. P. Mégnin.—Researches on red granules, by MM. J. Kunstler and P. Busquet.—The formations included under the name of red granules appear to be due to a diffraction phenomenon, and have no morphological value.—On a ferment of cellulose, by M. V. Oméliansky.—On the decomposition of chloroform in the organism, by MM. A. Desgrez and M. Nicloux. Experiments are described tending to show that during anæsthesia by chloroform some carbon monoxide is produced by the action of the latter upon blood.—On some comparative results of ordinary clinical methods and fluoroscopic examination in pleuretic effusions, by MM. Bergonié and Carrière. The examination by means of the Röntgen rays is valuable in many ways as a supplement to the ordinary clinical methods.—Antagonism between the venom of the *Vespidæ* and that of the viper; the first vaccinates against the second, by M. C. Phisalix.—Permeability of the trunks of trees to atmospheric air, by M. Henri Devaux.—On the disease of chestnuts, by M. E. Roze.—Characteristics of a gas coal found in the northern coal field of New South Wales, by M. C. Eg. Bertrand.—On the fauna of the siderolithic Eocene beds of Lissieu (Rhône), by MM. Ernest Chantre and C. Gaillard.—Mechanical determination of the mean direction of the wind, by M. Louis Besson.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 16.

ROYAL SOCIETY, at 4.30.—On a Method of Determining the Reactions at the Points of Support of Continuous Beams: G. Wilson.—The Comparative Chemistry of the Suprarenal Capsules: B. Moore and Swale Vincent.—Memoir on the Integration of Partial Differential Equations of the Second Order in Three Independent Variables: Prof. Forsyth, F.R.S.—On the Biology of *Stereum hirsutum*, Fr.: Prof. H. Marshall Ward, F.R.S.—An Examination into the Registered Speeds of American Trotting Horses, with Remarks on their Value as Hereditary Data: F. Galton, F.R.S.—On the Thermal Conductivities of Pure and Mixed Solids and Liquids, and their Variation with Temperature: Dr. C. H. Lees.—Cloudiness: Note on a Novel Case of Frequency: Prof. Pearson, F.R.S.—On the Occlusion of Hydrogen and Oxygen by Palladium: Dr. Mond, F.R.S., Prof. Ramsay, F.R.S., and Dr. J. Shields.—The Relations between Marine, Animal, and Vegetable Life: H. M. Vernon.

LINNEAN SOCIETY, at 8.—On the Affinities of the Madreporarian Genus Alveopora: H. M Bernard.—On West Indian Characeæ collected by T. B. Blow: H and J. Groves.

CHEMICAL SOCIETY, at 8.—Stereo-Chemistry of Unsaturated Compounds. Part I. Esterification of Substituted Acrylic Acids: Dr. J. J. Sudborough and Lorenzo Lloyd.—Formation and Hydrolysis of Esters: Dr. J. J. Sudborough and M. E. Feilmann.—A New Method of Determining Freezing Points of very Dilute Solutions: Dr. M. Wilderman.

FRIDAY, DECEMBER 17.

INSTITUTION OF ELECTRICAL ENGINEERS (Chemical Society's Rooms), at 8.—Accumulator Traction on Rails and Ordinary Roads: L. Epstein.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Elastic Properties of Steel Wire: Archer D. Keigwin.—The Elasticity of Portland Cement: W. L. Brown.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Physical and Ethnological Conditions under which Leprosy occurs in China, the East Indian Archipelago, and Oceania: Dr. James Cantlie.

SUNDAY, DECEMBER 19.

SUNDAY LECTURE SOCIETY, at 4.—Some Animal Co-operative Societies: Dr. Andrew Wilson.

MONDAY, DECEMBER 20.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.
IMPERIAL INSTITUTE, at 8.30.—Petroleum Sources of the British Empire: Boverton Redwood.

TUESDAY, DECEMBER 21.

INSTITUTION OF CIVIL ENGINEERS, at 8.—A New Transmission Dynamometer: Prof. W. E. Dalby.
ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Photomechanical Printing in Connection with the Survey of India: Colonel Waterhouse.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Agriculture in some of its Relations to Chemistry: Prof. F. H. Storer, 3 Vols., 7th edition (Low).—A Run round the Empire: Dr. A. Hill (Sonnenschein).—Studies in the Psychology of Sex, H. Ellis. Vol. 1. Sexual Inversion (Watford, University Press).—La Pratique du Teinturier; J. Garçon, tome 3 (Paris, Gauthier-Villars).—Annuario publicado pelo Observatorio do Rio de Janeiro, 1897 (Rio de Janeiro).—Whittaker's Mechanical Engineer's Pocket-Book: P. R. Björling (Whittaker),—All about Animals (Newnes).—Rainfall Tables of the British Islands, 1866–1890 (Eyre).—Das Problem der Krystallisation: A. Turner (Leipzig, Thomas).—Die Kraft und Materie im Raume: A. Turner, Fünfte Verte Auflage (Leipzig, Thomas).—Arii e Italici: G. Serg (Torino, Fratelli Bocca).—Meteorological Observations made at the Adelaide Observatory, &c., during 1894 (Adelaide).—Annuaire 1898: par le Bureau des Longitudes (Paris, Gauthier-Villars).—Sir James Young Simpson and Chloroform (1811–1870): H. L. Gordon (Unwin).

PAMPHLETS.—Human Nature, its Principles and the Principles of Physiognomy: "Physicist," Part 1 (Churchill).—Of Atmospheres upon Planets and Satellites: Dr. G. J. Stoney (Williams).—On *Chlamydoselachus anguineus*, Garm.. a Remarkable Shark found in Norway, 1896: R. Collett (Christiania).—Rainfall of the United States (Washington).

SERIALS.—Observatory, December, and Companion (Taylor).—Strand Magazine, December (Newnes).—American Naturalist, November (Philadelphia).—Mazama: a Record of Mountaineering in the Pacific North west, Vol. 1, No. 2 (Portland. Oregon).—American Journal of Science, December (New Haven).—Atlantic Monthly, December (Gay).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1897, Nos. 9 and 10 (Bruxelles).—Journal of the Anthropological Institute, November (Paul).—Journal of the Chemical Society, December (Gurney).—Engineering Magazine, December (222 Strand).—Astrophysical Journal, November (Chicago).—Monthly Weather Review, September (Washington).

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THURSDAY, DECEMBER 23, 1897.

THE GROWTH OF GEOLOGICAL IDEAS.

The Founders of Geology. By Sir Archibald Geikie. Pp. x + 297. (London: Macmillan and Co., Ltd., 1897.)

THE truths of science cannot be more impressively taught than by a sketch of the process by which the knowledge has been arrived at, and in no way can that history be more forcibly conveyed than in the biographies of those pioneers who first interpreted the phenomena for us. We may have wondered why the truth was not sooner grasped, but by this method of treating the subject we see what imperfection of evidence or prejudice stood in the way, and learn to appreciate the true spirit of original research which eventually rises above and overcomes all difficulties.

Sir Archibald Geikie has given a sketch of the founders of geology in his, now happily well-known, lucid style. It is necessarily only a selection, and accident or design has led him to make such a selection of points in the development of the subject as has enabled him to write what may be called an "appreciation" of the French school of geologists, and to dwell very fully on the work of some of them whose claims to recognition have hitherto been too much overlooked.

In the earlier stages of research all those who studied the composition of the earth's crust were called mineralogists, and any stony fragments which they dug out of the earth were their fossils. When men began to distinguish between bodies of organic and inorganic origin, they spoke of the pieces of rock and other mineral matter as *native* fossils, considering them as part of the original mass, while they called the remains of plants and animals *extraneous* fossils. It was only in comparatively recent times that the word fossil was applied exclusively to the remains of organisms. When the older writers speculated upon the manner in which the earth's crust had been brought into its present condition, they entitled their results "theories of the earth," which corresponded generally to our modern works on the principles of geology. Though they too often generalised on insufficient data, or wrested their judgment to support an early-formed opinion, they all pretended that their theories were founded on the study of nature; but we find many a good observation and sound inference buried under such a load of bad reasoning, and accompanied by such a cloud of foolish observations, that the writer's credit as a witness was destroyed, and even what was good in him lost sight of.

Our author passes with very brief notice over all the writers earlier than the eighteenth century, and devotes the greater part of his first lecture to a sketch of the work of Guettard: in a few clever touches he brings before us the personality of that remarkable man. Guettard first put into practice the proposal made by Lister in 1683, and constructed a map on which he showed the general surface distribution of the various kinds of rock as they occurred in broad belts in and around the Paris Basin, and even marked on it the places where he had found fossils. Later on, when a good topographical map of France had been produced, he indicated on it the characters of the rock over a very large area, completing the mineralogical survey of no fewer than sixteen sheets of the map. This was a work of great labour, and one involving very close observation, especially as he does not seem to have had any clear idea of the sequence of formations or of geological structure to guide him. Guettard was the first to recognise the ancient volcanoes of Auvergne, and deserves great credit for his able memoir on the meaning of the occurrence of the remains of shells and other organisms in the rocks. But the battle had long been raging between those who maintained that the fossils were mere *lusus naturæ*, and those who held that they represented plants and animals which once lived under conditions analogous to those of recent times, and were buried, as are dead organisms, in the mud and sand of to-day. In this long controversy many Italian and English geologists did good service, notably Agostino Scilla and Dr. John Woodward, who combated especially the erroneous views of Dr. Elie Camerarius; and although their work was hampered by the attempt to accommodate all their explanations to the received interpretation of the Scriptural account of the deluge, still the search for facts to support their theories helped on the work by calling attention to phenomena which might otherwise have long passed unobserved.

In his second lecture our author gives a sketch of the life and work of Desmarest. He tells us of the difficulties and struggles of his early life; of his official work in connection with the efforts made by the French Government in the middle of the last century to develop the industries of the country; and of the influence which the eloquent writings of Buffon had upon him. Desmarest was struck by the correspondence between the opposite cliffs of France and England which had already been pointed out by Guettard, and still earlier by Verstegan. Supporting by biological evidence the idea thus suggested, Desmarest arrived at the conclusion that the channel which now separated them had been cut by the currents of the sea.

His official duties necessitated much travel, but in the intervals of leisure he revisited and more closely examined localities which suggested subjects for further research. In this way he was led to study the origin of basalt, which had been a fruitful theme of controversy for many a long year. He noticed the prismatic structure of the basalts of Auvergne, and recognised them as ancient lavas, and, from descriptions of the general appearance of the columnar rocks of the Giant's Causeway, and an examination of hand specimens, he inferred that they were the same.

He explained the origin of valleys by referring them to the action of the streams which flow in them. This view had evidently been present to the mind of Avicenna, who in the tenth century maintained that mountains were made to stand out by the excavation of the valleys between them, while our great naturalist Ray dwelt upon the operation of streams in the degradation of the land, pointing out that the land must necessarily be eventually reduced below sea level by such agencies.

We are told how from an examination of volcanic phenomena, and in the attempt to correlate them, Desmarest was led to generalise upon the relation of

 I

the volcanic to the sedimentary rocks. He also constructed a map which, however, was not published till after his death. He has left many published works which attest his power, his accuracy of observation, and his judgment.

We have, then, an interesting account of the circumstances which led to the systematic exploration of Russia and the part played in it by Pallas, who, among other important observations, clearly recognised a geological sequence in passing from the centre to the outside of a mountain chain.

The rise of the modern spirit of mountaineering is dated from the time of de Saussure, who described so well the geological structure of the Alps, and whose sections of violently folded rocks anticipated so much of the recent work on that region, and whose experiments on the reduction of granite and basalt to a glassy rock by fusion and rapid cooling marked the commencement of experimental geology.

Our author then traces the development of the doctrine of the geological sequence of rocks as distinguished by their lithological character, towards which much had already been done, especially by the Wernerian school, and also the order of their formation as indicated by the succession of organic life buried in or associated with them, and differing in character at different periods of the world's history. The controversy as to the true nature of fossils, which has been referred to above, shows that importance had long been attached to them as a means of interpreting the history of the earth.

We have in the third lecture an account of Werner, the eponymous hero of a theory and a time. The great controversy between the Neptunists and the Vulcanists set men to search for facts in support of their respective views; and though a wrong working hypothesis may often have coloured the vision and warped the judgment, still the indications offered helped other less prejudiced men along lines where inquiry was fruitful. The Wernerian saw basalts interstratified with fossiliferous rocks, and apparently forming one member of a fossiliferous series, while others traced lava-flows with columnar structure from the crater to the sea, and saw how they might rest on ancient sediments and be themselves covered by newer deposits. Werner was wrong about his basalt, but he had introduced a greater care in investigation and a greater precision of description, and, above all, had so insisted upon the doctrine of geological succession that he placed geology upon a sounder basis than it had hitherto ever occupied.

Von Buch did much to free the scientific world from the tyranny of an uncompromising Neptunism by his demonstration of the constant occurrence of earth-movements down to quite recent times, as well as by many other independent researches recorded in numerous memoirs, and embodied in a large geological map of Germany.

If we give de Saussure credit for originating experimental geology, we must give Hutton a foremost place among those who insisted upon the importance of observation in the field. He was a man of wide interests and varied attainments. He realised the importance of Geology to Agriculture, and published works on "The Principles of Knowledge" and "The Progress of Reason from Sense to Science and Philosophy," this last title reminding us of Agostino Scilla's "La vana Speculazione disingannata dal Senso." The aims of both writers were the same, though Hutton got nearer the mark than his predecessor. In tracing the history of an idea, how often we find that the man who gave it to the world, in what we may call an available form, was not the man with whom it really originated. Take, for instance, the view that the action of heat in fusing material is directly influenced by the amount of pressure to which the body is subjected. This is quoted now with references to Sir James Hall, to Fairbairn and Hopkins, and others. But it was one of Hutton's fundamental doctrines, and Hutton got it from his friend Dr. Black, a sound chemist and shrewd experimentalist.

Hutton's first principle was that "no powers are to be employed that are not natural to the globe, no action to be admitted of except those of which we know the principle, and no extraordinary events to be alleged in order to explain a common appearance."

There are many men of note in our day who, going with the swing of the pendulum, as it were, believe in the greater intensity of the operations of nature in past ages, and still within the periods of which we have records in the sedimentary rocks. The phenomena which suggest this view may be reconciled to the strictest uniformitarianism by the doctrine that local catastrophic action is not inconsistent with continuity of causation.

Several distinguished French geologists, about the end of the last and the beginning of the present century, insisted upon the doctrine of stratigraphical sequence as fundamental, and this was soon found to involve the opinion that there was a definite order of succession among organic remains also. In England, while Giraud Soulavie was still a child, and before Cuvier or Brongniart were born, John Michell, Woodwardian Professor of Geology in the University of Cambridge, gave a clear account of the stratified arrangement of the rocks of England, and by his illustrations showed that he understood the principles of geological structure. "Let a number of leaves of paper," said he, "of several different sorts or colours, be pasted upon one another; then, bending them up into a ridge in the middle, conceive them to be reduced again to a level surface, by a plane so passing through them as to cut off all the part that has been raised. Let the middle row be again raised a little, and this will be a good general representation of most, if not all, large tracts of mountainous countries, together with the parts adjacent, throughout the whole world. From this formation of the earth it will follow that we ought to meet with the same kinds of earths, stones and minerals, appearing at the surface in long narrow slips, and lying parallel to the greatest rise of any long ridge of mountains; and so, in fact, we find them."

Then came William Smith, who based all his classifications on the "strata identified by their organic fossils." Sedgwick, who in early life had been the companion of Smith in some of his excursions in the north of England, was so impressed by the importance of the methods of geological research employed by Smith, that he spoke of him on one occasion before the Geological Society as "the Father of English Geology."

The next and last lecture brings us down to recent times, and the men whom many of us knew. In it we are told of the establishment of the Cambrian, Silurian and Devonian systems by Sedgwick and Murchison; of the discovery that glacial ice once gathered on the mountains of the British Isles; of the coordination of the wisdom of many observers by Lyell and Darwin in the enunciation of the great laws which guide the development of the organic and inorganic world; of the practical application by Nicol and Sorby of chemical and microscopic analysis to the identification of the minerals which make up the rocks, and often to the detection of their mode of aggregation.

The old controversy between Sedgwick and Murchison is introduced with a very skilful relative depreciation of Sedgwick; but perhaps the last has not been heard of that question, and it may yet be acknowledged that whereas the Arenig, Bala, and May Hill series were first clearly defined by Sedgwick, and placed in their true relative positions ("Life and Letters of Sedgwick," vol. i. 529-531; vol. ii. 510-563), the Llandeilo and Caradoc series were placed in their wrong order, and had the wrong fossils assigned to them in the "Silurian System" of Murchison, while the May Hill series was then unrecognised by him. Sir Archibald Geikie very fairly says that the middle disputed series must be either Upper Cambrian or Lower Silurian, and is unwilling to admit the new term Ordovician proposed for it.

Geologists owe a debt of gratitude to Mrs. George Huntington Williams, who founded the lectureship in memory of her distinguished and much lamented husband, the late Professor of Geology in the Johns Hopkins University. They will also accord their thanks to those who selected the first lecturer, and to him for his choice of a subject. T. MCKENNY HUGHES.

THE TWO BONDS.

Memorials of William Cranch Bond and George Phillips Bond. By Edward S. Holden. Pp. 296. (New York: Lemcke and Buechner, 1897.)

IN these days when one is rather inclined to forget who were the pioneers of astronomy in different countries, it is interesting to be able to obtain a volume in which are described the lives, the difficulties to be surmounted, and the success attained by those who have been in these critical positions. The two Bonds—William Cranch and George Phillips, father and son—may be regarded as the first important contributors towards the early history of astronomy in America; and as they were the first two directors of the now well-famed Harvard College Observatory, the earliest founded of any college observatory in the United States, an account of their lives and work is very welcome.

The present volume purposes to afford such information, and Prof. E. S. Holden, and those who have helped him, deserve great credit for this valuable contribution to the history of astronomers. Prof. Holden, as he tells us, became acquainted with the Bonds in his youth, and in the preface he speaks of the unfailing kindness which he and his young friends received at their hands when at the observatory. "It has been my fortune," he says, "as an observer, to repeat some parts of his (George Bond's) work, and to obtain in this way an even more accurate judgment of his persistent thoroughness."

William Cranch Bond's father was a true Cornishman, and it is said that the family never ceased to regret their immigration to America. "A loyal love of England was characteristic of the family for many years. In household customs, manners and traditions they were thoroughly English down to very recent days."

William at an early age turned his attention to astronomy, and when only fifteen years old (1804) constructed an excellent chronometer, and also a quadrant which proved a very serviceable instrument. His taste for mechanical contrivances was considerable, and, as is now well known, he became very distinguished in this direction. Much interesting information is brought together in this volume, which shows that William Bond's career was by no means a smooth one, although it was rewarded with great success. The chronograph, now an important adjunct to meridional work, we owe to his mechanical ingenuity, and it is interesting to note that he was the first American to be elected a Foreign Associate of the Royal Astronomical Society.

William's son, George Phillips, was perhaps even more remarkable than his father in the amount of work which he accomplished. His *Magnum opus* on the great comet of Donati is perhaps the best known of his contributions, but there are others which were of nearly equal importance. It may be mentioned here that he was awarded the gold medal of the Royal Astronomical Society for the splendid memoir just referred to, but the official notification of the award reached America some days after his death. The nebula of Orion was minutely examined by him in the winters of 1857-8-9, in order to check the drawing made by his father, and investigate the truth of the remarks of Otto Struve, who criticised the positions of the stars in the engraving. This memoir is also of considerable importance, and illustrates the thoroughness which he displayed in his observational work. George Bond's forecast of the future of photography in its application to celestial physics has shown that he thoroughly understood the whole question, and, as Prof. Holden remarks, "he is the father of celestial photography."

The volume before us contains several interesting extracts from the diaries of George Bond, which include many important facts about his life. The extracts from his notes, made during two visits to Europe in 1851 and 1863, will be found very pleasant reading, as Bond visited most of the important observatories on this side of the Atlantic. His interviews with and descriptions of the astronomers of that day abound with interesting matter. In an account of his visit to Paris, he says about Leverrier:

"In the frankness of his manners, in the absence of all *assumed* dignity, and in other points of resemblance, he is not unlike Mr. Adams. His straightforward way of expressing himself, and absence of all ostentation, render him what I should call accessible."

These diaries are followed by a collection of George Bond's correspondence, while the last chapter is devoted to an account of the scientific work accomplished by both the father and son. A useful appendix is added

containing a list of the scientific writings of the two Bonds, compiled by Mrs. Richard F. Bond.

We cannot bring this notice to a conclusion without referring to the admirable way in which the lives and work of these two men have been set forth, and to the excellent reproductions of those celestial objects which will always be connected with their name, namely, Donati's Comet and the Nebula of Orion.

WILLIAM J. S. LOCKYER.

OUR BOOK SHELF.

Hints to Teachers and Students on the Choice of Geographical Books for Reference and Reading; with Classified Lists. By Hugh Robert Mill, D.Sc., F.R.S.E. Pp. 142. (London: Longmans, Green, and Co., 1897.)

A BIBLIOGRAPHY is always a difficult work to compile satisfactorily, and it becomes an even more delicate undertaking when an eclectic method is followed. The "Bibliotheca Geographica," which Herr Otto Baschin edits for the Berlin Gesellschaft für Erdkunde, is an example of the comprehensive type of bibliography, and Dr. Mill's little book admirably represents the type which aims at being serviceable rather than complete. Of the direct value of the book to teachers of geography, and indirectly to the science of geography, there can be no question: what surprises us is that Dr. Mill should have had the temerity to prepare it. Few people care to publish lists of what they consider to be the best books on any particular subject; and those who do commit themselves are often afterwards visited with mild regret. The author of this book, however, occupies an exceptional position for knowing what geographical works are in existence, and his lists of books show that he has made his selections carefully and with a mind free from prejudice. The volumes are classified under seventeen different headings, and dealt with in as many sections. A chapter on the principles of geography forms a suitable introduction to the more practical part of the work.

But a list of books, even when annotated, is not a sufficient guide to a teacher, and it needs to be supplemented by a few remarks upon the general utility and educational value of the works mentioned. We are glad, therefore, that Dr. Mill precedes each list with a brief description of the particular branch of geography, or the continent, to which the books refer, and with hints on the use of the books. From the notes and the lists it is easy to learn what volumes are best to read, and where to turn for trustworthy information upon any geographical subject met with in ordinary life. The student may refer to the book with confidence, and the teacher of geography will benefit by taking it as his guide.

We notice that the volume was prepared at the request of the Geographical Association. The Association could find no better way to further its objects than by encouraging the publication of works of this character.

Sleep: its Physiology, Pathology, Hygiene and Psychology. By Marie de Manacéïne. Pp. vii + 341. (London: Walter Scott, Ltd., 1897.)

THIS book is divided into four chapters dealing with the subdivisions of the title. A good account is given of the phenomena and theories of sleep. The chief abnormalities are well described, and the author includes an account of certain allied conditions, such as double consciousness and Latah. The references to general pathology in this section are apt to be somewhat antiquated, as when the mental enfeeblement of goitre is ascribed to withdrawal of blood from the brain. The subject of hygiene of sleep is evidently that to which the special work of the author has been devoted. She lays great stress on the proper management of sleep, and has somewhat novel views on the evils of prolonged sleep, and of fixed hours for sleep, and on the harmfulness of rocking babies in order to make them sleep. She describes very fully a condition which she terms the hypnagogic or half-awakened state, a condition characterised by increased suggestibility which is regarded as having an unfavourable influence on the mind if allowed to become well developed.

The chapter on psychology is devoted chiefly to dreams, of which a good systematic account is given, without anything especially new. The author seems to regard dreaming as an indication of high mental development; "dreams increase with the variety and activity of mental life," because intellectual workers dream more than servant girls. May this not be due to the fact that servant girls are usually the sounder sleepers?

Lessons from Life, Animal and Human. With an Introduction by Rev. Hugh Macmillan, LL.D. Pp. xvi + 529. (London: Elliot Stock, 1897).

THIS book is intended for preachers and Sunday-school teachers, and the lessons which it draws are not inferences but moral analogies. Thus an account of the bower bird establishes the maxim that "the relief times of life secure bodily and mental energy, and good spirits." The advertisements at the end of the book inform us that there are several volumes on the same plan, and that they have a good sale. The one before us is a compilation from many authors, with Darwin at one end of the scale and a crowd of obscure or anonymous writers at the other. The author is not particular in his choice of materials. He draws lessons from the most unlikely stories, and his familiarity with the literature of natural history can be estimated by the fact that he attributes to George Shaw the delightful account by Gilbert White of the behaviour of Timothy, his tortoise, in a shower of rain. The illustration or epigram from nature, which is so attractive in Shakespeare and other great writers, is here reduced to a "sad, mechanic exercise." When the allusions and emblems are arranged in cyclopædias, so that the preacher has only to look up a virtue or a vice in the index to find a more or less appropriate analogy, it is plain that the didactic anecdote is now "hackneyed and worn to the last flimsy thread."

L. C. M.

All about Animals, for Old and Young. Oblong 4to. (London: George Newnes, Ltd., 1897.)

ALTHOUGH the title is somewhat pretentious, this collection of large size photogravures is an enormous advance on the old-fashioned animal picture-books; and the volume forms an attractive Christmas gift for young people interested in natural history. All the plates are good, and some are excellent, although a few suffer from over-enlargement. A naturalist will, however, notice that one plate of deer is wrongly named; and a few emendations might here and there be suggested in the explanatory letter-press. This is for the most part well and brightly written, and serves to enhance the interest of the figures. In the first half of the book the greater number of the illustrations are from photos by Mr. Gambier Bolton, but in the second half other artists' names appear. And many of these latter are merely repetitions of the animals figured in the first half. This is decidedly a pity, as many other species might have been introduced. In a future edition these replicas might be replaced by others; and a rearrangement of the whole series in some sort of order would also be advisable. Even as it stands the book ought to, and doubtless will, command a large sale.

R. L.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Transpiration into a Space Saturated with Water.

FOR some time past[1] I have been endeavouring to decide whether the energy used in raising the water of the transpiration current is derived solely and directly from the inflow of heat at the evaporating surfaces of the leaf-cells, or whether stored energy (*i.e.* vital force) is in any way responsible for work done.

It has been observed that plants transpire into a space saturated with moisture. But I am not aware that it has been pointed out that this transpiration will continue even when no light falls on the leaves. Without this precaution we cannot assume that the space is really saturated at the surface of the leaves; for they will convert some of the light into heat, and so lower the state of saturation at their surfaces.

In my experiments small leafy branches were cut and set in a watery solution of eosin under a glass receiver. Beside the vessel containing the eosin, and under the receiver, a beaker filled with boiling water was placed. The receiver became immediately filled with water vapour, and, as the space was continually falling in temperature, owing to the cooling of the beaker, it remained always in a state of saturation. These arrangements were made in a feeble light, and then the receiver branch and all were set in total darkness. It is to be mentioned that a wet board cut off the direct radiation of the beaker from the branch. After an hour it was found that the eosin had risen into the leaves of the branch. In order to ensure that this rising was not due to reduced air pressure, previously obtaining in the water conduits of the branch, experiments were made in which any reduced pressure was equalised by setting the branch for one hour standing in water under the receiver, before setting it in eosin. The same result was obtained in these cases.

The raising of the eosin in this experiment seems probably due to a pumping action in the cells of the leaf, depending upon vital processes taking place there. This surmise is confirmed by the fact that the elevation of the eosin does not take place in a saturated atmosphere if the leaves have been killed. This may be proved either by leaves killed by immersion in water at about 90° C., or by exposure to chloroform vapour.

If the pumping action be a "vital" process we would expect it to be dependent upon a supply of oxygen, like growth and grotropic curvatures, &c. We, in fact, find this to be the case. Thus a branch wholly surrounded by water will draw up eosin from a vessel below, if exposed to light. The raising of the eosin will be but little if the light be cut off from the submerged branch. The action of light supplies the leaves with oxygen set free by assimilation; in the dark, however, the leaves can only obtain the small amount of oxygen dissolved in the water, and perhaps a little, too, derived by intramolecular respiration. With this limited supply the elevation of the eosin is inconspicuous.

The oxidising processes taking place in the leaf-cells must bring about some minute rise in temperature. This will, of course, favour evaporation. But I think this effect would be far too small to account for the whole phenomenon of transpiration into saturated spaces, as I have here described it.

That a very considerable amount of the pumping action is located in the leaves, may be shown by employing large leaves set upright in the eosin. It will be found that in a dark saturated space the veins of such large leaves severed from the stem will quickly become injected with the colouring fluid.

HENRY H. DIXON.

Trinity College, Dublin, December 14.

[1] *Cf.* Report of a Discussion on the Ascent of Water in Trees, *Ann. of Bot.*, December 1896.

The Zeeman Effect Photographed.

IN the number of NATURE issued on September 2, 1897, a short account is given (p. 420) of the recent work which has been done in the study of "the radiation of light in the magnetic field," and it is there remarked that it would be very desirable if the effects described by Prof. Zeeman were reproduced by photography. This, indeed, appeared to be all the more necessary in consequence of the doubts expressed and entertained as to whether the effect was a simple broadening of the spectral lines, or the production of doublets and triplets, or a combination of both effects. I accordingly availed myself of the opportunity afforded me, through the courtesy of the Royal University, of using for this purpose the splendid Rowland's concave grating mounted in the Physical Laboratory at Earlsfort Terrace, Dublin.

After the usual amount of preliminary difficulties and failures, I have finally succeeded in actually photographing all the appearances described by Prof. Zeeman, and I herewith enclose three small negatives which show the general character of the phenomena, and verify Zeeman's observations.

I do not now propose to enter into any particulars as to measurements, &c., so I shall merely describe the photographs.

The line represented is the violet line of cadmium which lies nearest to the blue, its wave-length being 4678. Plate A is taken with the slit viewing the spark *across* the lines of force of the magnetic field. The electro-magnet being excited, we have the triplet marked 1. The current was then turned off, and 2 was taken, which shows the line in its normal condition. A nicol was then inserted between the lens and the slit, and 3, 4, 5 were taken. Of these 4 shows the line when the magnet is not excited, while 3 and 5 were taken with the magnet excited. The position of the nicol in 5 was at right angles to that in 3, and as in 5 the side lines of the triplet have disappeared, it is proved that they are plane polarised. A faint middle line is shown in 3, but in my other photographs this line of the triplet is very weak, showing that it is mainly plane polarised in a plane at right angles to that of the side lines of the triplet. This is shown more distinctly in plate B, where 6 and 8 were taken with the excited field and the nicol interposed, the position of the nicol in 8 being at right angles to that in 6. The line marked 7 was taken with the magnet unexcited.

The third plate, C, was taken with the slit viewing the spark *along* the lines of force in the usual way through an axial aperture in one of the pole-pieces. In this plate the line marked 9 was taken with the magnet unexcited, whereas 10 was taken with the field excited. The latter is a distinct doublet, and a photograph which I took to-day with a quarter wave-plate and a nicol interposed, shows that the lines of the doublet are circularly polarised in opposite senses.

I wish to thank Dr. W. E. Adeney, the curator of the University laboratories, by whom the grating was mounted, for all the trouble he took to facilitate my work, and also Prof. Barrett, of the Royal College of Science, who kindly lent me his electro-magnet.

THOMAS PRESTON.

P.S.—You will observe that all the effects described above are clearly visible on the plates (which I have forwarded) by aid of any ordinary magnifying glass. They lend themselves admirably to lantern projection, and when thrown on a screen the effects may be shown to a large audience. It is to be clearly understood, however, that the description above applies to this particular line (it is also true for other particular lines); but it is not implied that the same effect precisely is produced in every other line, either of the same or of different substances.

I am making further observations on this latter point, and hope to publish my results shortly.

T. PRESTON.

November 19.

[The negatives referred to by Mr. Preston show clearly the effects described, but they do not lend themselves to satisfactory reproduction, even when enlarged.—ED. NATURE.]

The Small Tortoiseshell Butterfly in December.

I SEE in more than one daily paper of this morning's date a paragraph announcing the appearance of a small tortoiseshell butterfly in Highgate Police Court yesterday as something unusual.

This butterfly is more or less common wherever nettles grow freely, and there is a succession of broods throughout the fine season, the last of which hibernates and reappears early in spring (in mild winters in the southern counties as early as February, or perhaps occasionally even in January). It is easily disturbed in its winter quarters, so there is really nothing surprising about its appearance now. The small tortoiseshell is usually one of the latest butterflies to retire from notice in autumn, and one of the first to reappear in spring.

Chiswick, December 21.

W. F. KIRBY.

NYASA-LAND.[1]

SIR HARRY JOHNSTON has had a unique opportunity, and he has made the most of it. Most areas in Africa over which European protectorates have been established during the past twenty years are vast in size, varied in population, as a rule unhealthy in climate, and commercially unprofitable. In the Congo Free State, Rhodesia, British East Africa, Damaraland, German East Africa and Erithrea, all the best efforts of the administration have been necessarily devoted to a struggle against almost insuperable difficulties. In these cases the leaven of European yeast is so small in proportion to the vast bulk of African meal, that one part of the mass has begun to putrefy before the rest has lightened.

It fell, however, to Sir H. H. Johnston's lot to administer a district of exceptional promise, in which a group of Scotch planters and missionaries had been settled for many years. He found a number of men willing to help, and already possessing a considerable knowledge of the country and people. The protectorate s comparatively small and compact; and yet it includes a varied series of soils and climates. Most of the district is—for tropical Africa—fairly healthy. The natives are all Bantu. The Administrator was well backed financially, and had the implicit confidence of the Foreign Office officials. Hence he had an opportunity for developing the country on experimental lines that might make it a model for the larger and more chaotic European protectorates. How far Sir H. H. Johnston has succeeded in this task is shown in the magnificent work which he has published at the end of his term of office in Nyasaland. That is, however, a political question, which need not therefore be considered here, and we may at once pass to the consideration of the section of the work of scientific interest. For Sir Harry Johnston is fortunately a man of culture and scientific tastes, which his position gave him opportunity to satisfy. Hence at the end of his term of office in Nyasaland he has been able to publish a monograph upon the country, describing its history, its climate, its people, fauna and flora. The Germans have made great progress with an elaborate monograph upon German East Africa; but that is the work of a large staff of officers, whereas Sir Harry Johnston's is a one-man book, based on the studies carried out by a busy official during the intervals of administrative worries.

The title of the work, "British Central Africa," is somewhat confusing, as the author uses the name in two different senses: on the title-page and maps it includes all the British territories between the Zambesi on the south, and German East Africa and the Congo Free State on the north. It was in this sense that the term was originally proposed, at a time when it was hoped that the Blantyre Highlands would have been the administrative centre for a vast British territory, which would have connected British East Africa with the British dominions south of the Zambesi. Sometimes in the book the name British Central Africa is used in its original sense, and sometimes only as a synonym of Nyasaland Protectorate; excluding the western five-sixths of the country, which in 1894 were transferred to the administration of the British South Africa Company. Thus on pp. 152–154 there is a summary of "the present method of administration of British Central Africa," in which only the Nyasaland Protectorate is considered. Any one who failed to recognise the double sense in which the author uses his title, might infer that no progress has been made in the administration of the vast territory to the west of Nyasaland. It would, perhaps, have been as well to have entitled the book the "Nyasaland Protectorate," for the monographic treatment, which is its main merit, is entirely limited to that area. The great western territories are often referred to; but so scanty is the treatment they receive, that the name of that hardworking administrator Major Forbes is not even mentioned.

FIG. 1.—Captain Sclater's road to Katunga in process of making.

The book opens with a series of graphic descriptions of the various types of country included in British Central Africa, using the term in its wider sense. The author vividly depicts the beauties of the jungle-bordered rivers, of the scrub-covered foot hills, of the cypress forests near the mountain summits, of the meadowland on the high plateau, of the rough, craggy, granite kopjes, and of the squall-tossed lake. Included among the word pictures of these beautiful scenes is a graphic sketch of the death-bed of a mining prospector, which would not be out of place in a religious tract.

The second chapter gives a short account of the physical geography of the country, accompanied by three admirable maps and a series of excellent illustrations. The political history follows. There is a brief summary from prehistoric times up to 1889. One interesting suggestion here advanced is that the ancestors of the existing Bantu inhabitants of Southern Africa first invaded the region south of Lake Chad about 2000 years ago—a conclusion based on the wide distribution of the native name for fowl. After 1889 the history naturally becomes more detailed, for then began Sir H. H.

[1] "British Central Africa. An Attempt to give some Account of a Portion of the Territories under British Influence North of the Zambesi." By Harry H. Johnston, K.C.B., F.Z.S., &c. 8vo. Pp. xix + 544, with 6 maps and 220 illustrations. (London: Methuen and Co., 1897.)

Johnston's connection with the settlement. Chapters follow on the slave trade and on the European settlers; future additions to the ranks of the latter are advised in an appendix that civilisation has reached a stage in the Shire Highlands which makes a dress suit more useful than a pith helmet. A special chapter is devoted to the missionaries, to whom the country owes much; the debt is fully acknowledged, but the missionaries are reproached for the cant and the inaccurate reports written to "gammon" the British public.

The last four chapters of the book deal with the natural history. The botanical section includes a valuable list of Nyasaland plants compiled by Mr. J. H. Burkill. The first collections were made by Sir John Kirk in 1861 and 1862; and judging from the frequent repetition of the names of collectors in the catalogue, the three principal subsequent contributors have been Prof. G. F. Scott-Elliot and Messrs. J. Buchanan and A. Whyte. The general chapter on the flora calls attention to the most conspicuous and interesting plants; the remark of most general interest in this section is the author's repeated protest against Dr. Russel Wallace's well-known view that the tropics have less gorgeous displays of bloom than temperate regions, an impression, Sir Harry Johnston remarks, "formed from an exclusive acquaintance with the dense forests of Tropical America and Malaya."

The zoological chapter consists of lists of the animals, most of which have been determined by the staff of the zoological department of the Natural History Museum, with general notes by Sir Harry Johnston. The lists of insects are relatively the shortest, but the author confesses to "a sweeping hatred of the insect race" "It is surprising, to my thinking," he remarks, "that our asylums are not mainly filled with entomologists driven to *dementia* by the study of this horrible class." He says he cannot call to mind "one insect that is of any benefit to man . . . with the doubtful exception of the bees and the Cochineal Aphis," ignoring, therefore, the scavenging function of the flies, the chemical and medicinal products of the galls, the silkworm, and other such invaluable servants of man. The author appears most interested in the mammals, among his notes on which some original suggestions are made. With the author's usual courage, he runs a tilt against zoological nomenclature; he objects to Burchell's zebra being regarded as the type of the species "merely because it was the first one to be discovered"; and then renames the species *Equus tigrinus*. The varieties *burchelli*, *chapmani*, and *granti* he regards as only varieties of *Equus tigrinus;* while the name *Equus crawshayi*, that of the Nyasaland zebra, is ignored altogether. Sir Harry Johnston's views on phylogeny are as much his own as his methods of nomenclature. He publishes (p. 310) a diagram showing "the origin and relationships of modern groups of Horned Ruminants." According to this novel diagram the giraffe, which is usually regarded as a descendant of *Sivatherium*, is represented as one of the offspring of the Chevrotains. The prongbuck, definitely included by the author among the antlered ruminants, is shown as a branch of the giraffe stem. All the antelopes, sheep, and goats and the musk-ox are derived from the Capricorns, a group which is again a direct descendant from the Tragulidæ or Chevrotains. Early in the work the author tells us that our views on the relations of African mammals may be at any time "upset by unlooked-for discoveries," and too late in the day illustrates this view by referring to *Nesopithecus* (*sic*), a discovery which he describes as of "the most extraordinary importance and interest," apparently unacquainted with the recent literature of the subject.

The last section of the monograph describes the people, and here the author speaks as an expert as well as an enthusiast. The section includes a most valuable series of vocabularies, and detailed descriptions of the people and their habits. Some of the descriptions, indeed, are probably too detailed; much is recorded, though half veiled in dog Latin, which might have been more appropriately relegated to the pages of a strictly anthropological journal, instead of being published in a work the rest of which is suitable for general circulation.

The author's eulogy of his colleagues, notably the present Commissioner Mr. Alfred Sharpe, and his tribute to the chivalrous courtesy with which the Portugese always behaved in their relations with him, are instances of the author's tact and fairness, and they illustrate the spirit in which the work is written. The book is in every way worthy of Sir Harry Johnston's industry and scientific attainments, and will remain the most enduring memorial of his seven years' work in the development of the most promising of our tropical African possessions. Moreover, the illustrations, two of which

FIG. 2.—A Male Reedbuck's Head.

are here reproduced by the courtesy of the publishers, are probably the best ever issued in an English book on Africa.

CHRISTMAS MUMMERS.

PROBABLY not a few readers of NATURE have, while staying over Christmas at a country house, been asked into the hall during the evening of Christmas Eve to witness a strange and fantastic rural performance called the mummers' play, and probably, too, they have promptly dismissed the whole thing as an idle and unmeaning piece of country folly. They would have noted, perhaps, the rude dialogue, the characters of St. George, the Prince of Paradine, and the King of Egypt; and they would have concluded that the performance was a faint echo of some miracle play of the Middle Ages, when the Church adopted this means of teaching the people.

Alike in the dismissal and in the uncareful noting of the characters, these observers of the country folk would have been wrong. The Christmas mumming play is worth attention, and more than mere casual attention.

Like other things which are done by the peasantry periodically, it is done by tradition, and traditional doings have a habit of getting weather-worn, so to speak. Some portions of them will remain fairly prominent, other portions will be more obscured; and so the proper sense of proportion among the different parts of the once perfect whole has disappeared. This is what has happened with the mumming play. St. George and his Eastern companions have remained in undue prominence with reference to other characters, and hence it has come about that the really archaic character of these plays has been lost sight of.

I need not describe the performance. Versions have been printed in the *Transactions* of the Folk-lore Society, and they have been examined scientifically by Mr. Fairman Ordish; but I will try briefly to explain the origin of these mimic representations of forgotten things.

The first thing to observe about the play is that the dialogue is in a state of decay. To restore it to anything like its earlier form would require the careful collation of all the versions with a view of ascertaining the portions that are practically common to all, the portions that are common to only a few variants, and the portions that are unique. This operation needs extension, too, beyond the mere mummers' play, for there are the Pace Egg play, the sword dance, and the Plough Monday play, which have most of the characteristic features of the mummers' play, and cannot but be products of the same original. After the dialogue is duly examined, there is the action of the play to consider. It is remarkable that all the actors in the different parts of the country from North England to Cornwall, however widely they differ in their dialogue and in the names of their characters, differ very little, if at all, in their action. The chief features of this action are found to be (1) the drawing of a circle with a broom for the place in which the play is to be performed; (2) the fight, in which the swords are very carefully locked together round the neck; (3) the death and revivification of the champions; (4) the costume of the characters, partly made of paper to imitate armour, as some writers have thought, but leaves of trees, as I think I shall be able to prove, and partly in imitation of animal characters.

Now in this traditional form of acting and of dressing there is more of archaic survival than in the dialogue part of the play. The circle which is formed for the players to act in is meaningless, unless it be interpreted as a magic ring drawn or constructed by the broom—that is the magic weapon of the witch, about which Prof. Karl Pearson has recently written so ably. The invariable position of the sword leads us to its parallel in the sword dance of the north of England, and hence to innumerable links with Scandinavian ritual. The death and revivification of the warriors is the reproduction of that eternal contest between winter and spring, which is to be found throughout the agricultural ceremonials of the European people, and which Mr. Frazer has examined so thoroughly. The costume of the players, some examples of which, thanks to Mr. Fairman Ordish, are to be found in the Anthropological Museum at Cambridge, connects the characters with the ritual belonging to the tree and animal cults of an almost dateless past. And in the whole thing we have, I doubt not, one of those "manifold though never developed germs of dramatic representation" of which Grimm gives some interesting examples, and which he explains "can be traced up to the most antique festivities."

Let me shortly state the arguments in support of this view. The contest, the death, and the revivification, are the central factors which need explanation, and this can best be done by examining their accompaniments, the setting, so to speak, in which they are embedded. We first of all dismiss the period of Christmas as being the special period of these mumming plays. It has grown to be so now; but that this is a late growth is shown by the fact that the same play is to be found, performed under another name, the Pace Egg, at Easter, and that significant parts of the same play are to be found performed as the Plough Monday play of early spring time. This agrees with the rule of most of the surviving traditional festivals attached to particular periods or dates of the Christian calendar. They are at some places attached to one festival, in other places attached to another, and it seems certain that these ancient ceremonies were transferred to the Christian season most favourable locally to their continuance, but not necessarily the same period of the year as they were originally performed. Without then fixing upon any of the Christian festivals as the archaic season for the play taking place, we may leave the question of date open, to be settled by other considerations. The next important point is the costume. Examining this carefully from the very modern examples which are preserved, we may conclude that the use of paper is but the adaptation of the cheapest material to be got for the purpose required. Now the paper dress is formed by stitching together a series of small pieces in a sort of scaly fashion, and the only two suggestions to account for this are first scale armour, secondly leaves. Against the idea of scale armour being present in the minds of the rustic performers there is much to be said, and particularly that scale armour is not in accordance with the other conditions of the play. In favour of leaves being intended there are many examples, notably the Jack-in-the-Green of May Day, of such dresses being used in these popular dramas; and, further, there is the fact that some of the mummers, or maskers as the name implies, formerly disguised themselves as animals—goats, oxen, deer, foxes, and horses being represented at different places where details of the mumming play have been recorded. It seems, then, that we have as data for ascertaining the principal features of the mumming play: (1) the undoubted fact of animals being represented; (2) the deduction that trees were also represented; (3) a contest, which resulted in the death of one of the opponents; (4) the restoration of the dead to life. Now mimic representations of an archaic ceremony in which actors take the parts, both of animals and trees, are found all over Europe, and they take place at spring time, just when leaves have once more appeared after the desolation of winter. This association of facts in the spring-time festivals can be equated with the association of facts in the mumming plays with sufficient precision to make it safe to conclude that the equation is due to a descent from a common original.

What is that original? In the personages who are thus slain in mimicry, to adopt Mr. Frazer's language, it is impossible not to recognise representatives of the tree spirit, or spirit of vegetation, as he is supposed to manifest himself in spring. The object of slaying the spirit of vegetation at any time, and above all in spring, when his services are most wanted, is that the divine life, incarnate in a material and mortal body, should be conveyed from the old representative of the god to a new incarnation. The killing of the god is only a necessary step to his revival or resurrection in a better form. Students of Mr. Frazer's work will not need to be reminded of the details of this argument, but I point out that they explain adequately not only the leafy and animal dresses of the English mummers, but the death and revivification of the principal actors; and they find their most archaically developed form in the Norse mythic fight between Thok and Balder, in other words between winter and spring.

What then, it may be asked, is to become of St. George and his Eastern companions, if all, except these, have so great an antiquity? The answer is that they are the later engraftings, and the answer is fortunately one

which can rather confidently be given. Folk-drama, like other branches of folk-lore, needs studying carefully and minutely to see what its chief essentials are. It is clear that the Church could not repress the dramatic representations of the people. So they utilised them. They turned characters belonging to the primitive religion into characters bearing the names of, and having just the slighest resemblance to, Christian characters. St. George was a knight who fought and slew enemies. He was fitted to do the fighting therefore in these old plays. But he did little else. He had to conform to traditional ways, if he introduced non-traditional speeches. He had to see his slain enemies restored to life, and he had to dress in the traditional manner and meet the traditional animal characters. Except, indeed, for the names of the characters there is nothing in these mumming plays really belonging to Christian knighthood and feudal nobility. No one would dream of attributing to them any of the dignity of romantic chivalry; they remain as they were originally, traditional representations of popular festivals. There is only the rudest action and the most archaic ideas: and it is not difficult, therefore, to get rid of the thin veneer of ecclesiastical influence in order to search for the more archaic relics underneath.

Laurence Gomme.

NOTES.

At a meeting on December 15, Sir W. H. Flower, K.C.B., F.R.S., was elected an Associate of the Royal Academy of Sciences of Belgium.

Prof. G. Carey Foster, F.R.S., will resign the Quain Professorship of Physics, University College, London, at the close of the present session.

Dr. Augustus D. Waller, F.R.S., Fullerian Professor of Physiology and Comparative Anatomy at the Royal Institution, has resigned his chair.

It is with deep regret that we announce the death of Prof. T. Jeffery Parker, F.R.S., professor of biology in the University of Otago. Though Prof. Parker died on November 7, the news has only just reached this country; and it is given melancholy interest by the fact that the "Text-Book of Zoology," upon which Prof. Parker had for some time been engaged with Prof. Haswell, was only completed a few days before his death.

The Council of the Chemical Society have recommended the following as Foreign Members to be balloted for at the next meeting, January 20:—Prof. Remsen, Baltimore, U.S.A.; Prof. Troost, Paris; Prof. Moissan, Paris; Prof. Raoult, Grenoble; Prof. Ostwald, Leipzig; Prof. Curtius, Bonn; Prof. Mensutkin, St. Petersburg; Prof. Markownikow, St. Petersburg; Prof. Arrhenius, Stockholm; Prof. Waage, Christiania; Prof. Franchimont, Leyden; Prof. van der Waals, Amsterdam; Prof. Spring, Liége; Prof. Körner, Milan.

We regret to learn that Prof. Francesco Brioschi, president of the R. Accademia dei Lincei, died at Milan on December 13.

The *Athenæum* announces that the mineralogist Dr. Albrecht Schrauf, author of several scientific works—among others of a "Lehrbuch der physikalischen Mineralogie," of a "Handbuch der Edelsteinkunde," and of an "Atlas der Krystallformen,"—has just died at Vienna in his sixtieth year. Dr. Schrauf was professor of mineralogy at the University of that place, and director of the Mineralogical Museum.

The death is announced, at Cape Colony, of Prof. James Holm, late Professor of Physics at the South African College Cape Town. Prof. Holm (says the *Electrician*) was born in Argyllshire in 1869, and had a brilliant career at Glasgow University, passing on to Edinburgh. Subsequently he spent several sessions in private research, under the special direction of Lord Kelvin, in the physical laboratory of the Glasgow University, and also in the electrical engineering workshops. At the completion of his scholarship he was appointed Demonstrator in Physics at the University College, Nottingham, where he remained until appointed to a professorship at the South African College in 1895.

Mr. H. F. Donaldson, Engineer-in-Chief of the London and India Docks, has been appointed Deputy Director-General of the Ordnance Factories.

The sub-tropical Botanical Laboratory at Eustis, Florida, has been abandoned, and the work transferred to the Division of Vegetable Physiology and Pathology of the Department of Agriculture, Washington.

Mr. A. C. Harmsworth has presented his Arctic ship *Windward* to Lieutenant Peary, and will have her overhauled and sent to America for his use in his coming Arctic expedition. This generous act is the latest incident in that series which has shown that England and America are bound by the strongest brotherly ties in their mutual interest in Arctic work.

Prof. Oliver Lodge will commence his course of six lectures (adapted to a juvenile auditory) upon "The Principles of the Electric Telegraph," at the Royal Institution on Tuesday next, December 28. The subjects of the individual lectures are:—The production of an electric current; detection of an electric current; land telegraphy; ocean telegraphy; principles of wire and cable signalling; space telegraphy.

Christmas lectures for juveniles are increasing in favour. At University College, Liverpool, Prof. Herdman, F.R.S., will give a course of three lectures and a museum demonstration, on some of the more attractive parts of natural history, during the Christmas holidays. The announcement states that the course is for boys and girls, for whom the best places will be kept; adults will only be admitted on sufferance, should there be room for them.

The following are among the papers announced for reading at the meetings of the Society of Arts after Christmas, in January and February:—"The Projection of Luminous Objects through Space," by Mr. Eric H. S. Bruce; "Fireproof Construction of Domestic Buildings," by Mr. Thomas Potter; "The Cinematograph," by M. Jules Fuerst.

The will of the late Dr. George H. Horn (says *Science*) gives his valuable entomological collections, together with his entomological books and instruments and an endowment of 200 dols. per annum, to the American Entomological Society. From the residuary estate, after the death of his sister, the Entomological Society is to receive 5000 dols., the Philadelphia Academy of Natural Sciences 1000 dols., and the American Philosophical Society 500 dols.

At the recent annual meeting of the Institution of Civil Engineers it was announced that, in respect of papers read during the Session 1896–97, the Council had made the following awards:—The Institution premium, value 10*l.*, to Mr. W. M. Mordey for his paper entitled "Dynamos"; the Paris Electrical Exhibition premium, value 5*l.*, to Mr. John Gavey for his paper on "The Telephone Trunk Line System in Great Britain"; the Fahie premium, value 5*l.*, to Mr. Benest for his paper on "Some Repairs to the South American Company's Cable off Cape Verde in 1893 and 1895." An extra premium of 5*l.* was awarded to Mr. A. P. Trotter for his paper on "The Disturbance of Submarine Cable Working by Electric Tram-

ways." The Council have decided to increase the number and values of the annual premiums commencing with the Session 1897-98 The Willans premium, the value of which the Council have increased to 25*l.*, has been awarded to Mr. Mark Robinson (member) for his paper entitled "On the Recent Development of the Single-Acting High-Speed Engine for Central Station Work."

MR. G. E. BROWN writes upon a proposed memorial to Henry Fox Talbot, in the *British Journal of Photography*. All photographers are aware of the value of Fox Talbot's researches; in fact, modern photography would have no existence but for the labours of the inventor of the calotype process. Yet, as Mr. Brown points out, no mark of appreciation of his services has been made. At Bry-sur-Marne stands a monument to Daguerre; Chalons can show one to Nicephore Népce; but Lacock, in Wiltshire, the home of the Talbots, can display no sign of public gratitude. The memorial proposed is the restoration of the chancel of Lacock Church, where Fox Talbot's father and many of his ancestors, as far back as the sixteenth century, lie buried. It is probable that a more distinctly commemorative character may be given to some definite feature in the chancel, such as a window, but the whole chancel will be commemorative. Subscriptions are invited, and may be sent to the "Fox Talbot Memorial Fund," Capital and Counties Bank, Chippenham.

THE report of the Departmental Committee appointed by the Home Secretary to inquire into the testing of explosives for use in coal mines has just been issued as a Parliamentary paper. It is recommended that explosives be tested in a highly explosive mixture of coal gas and air only, and the Committee feel confident that any explosive which shows itself superior in this mixture would exhibit the same increase in safety in the presence of a coal dust mixture. Taking into account the general results of the experiments, the Committee have drawn up a test, and recommend that this should be applied to all explosives which are submitted for inclusion in the permitted list. The full details of this test are given in an appendix. The amount of the charge which it is proposed to fire will be the equivalent of 2 ozs. of dynamite and of 6 ozs. of gunpowder. In order to pass the test an explosive must not cause more than two failures in forty shots, a failure being defined as either an ignition of the gaseous mixture or an incomplete explosion. After most careful consideration it has been decided to recommend that the test be carried out with a stemming of nine inches of dry powdered clay of good quality well rammed over the charge.

THE Trustees of the British Museum have decided to discontinue the opening of the Exhibition Galleries on week-day evenings from 8 to 10 p.m. after the close of this year; and, instead, to keep them open until 6 p.m. all the year round. The evening opening commenced in February 1890, on the installation of the electric light; the galleries, however, being opened only in sections, as the electric plant is not powerful enough to light up the whole building. At first the eastern and the western portions of the Museum were opened on alternate week-day evenings; but the number of visitors so rapidly declined, that the galleries were afterwards further subdivided into three sections. The numbers, however, have still continued to decline. The experiment of evening opening, having thus had a fair and patient trial, will now be abandoned; and a lengthened exhibition by day will be substituted, during the months when the Museum has hitherto been closed at 4 p.m. or 5 p.m., according to the season of the year. On and after Monday, January 3, the Exhibition Galleries will be kept open throughout the year from 10 a.m. to 6 p.m. It is believed that the extension of time will be appreciated by visitors, particularly during the winter months, when hitherto the closing hour has been 4 p.m. The arrangements for opening on Sunday afternoons will not be altered; visitors being admitted at hours varying between 2 p.m. and 7 p.m., according to the season of the year.

THE severe gale of November 28 and 29, which caused such serious damage all along the south-east coast of this country, had the effect of raising the tide to an abnormal height, the tide of the following day being considerably depressed. Writing in the *Engineer*, Mr. W. H. Wheeler says the wind appears to have had the greatest effect in increasing the height of the tide along the part of the coast extending from the Humber to the east end of the English Channel. The wind on the previous days had been blowing strongly from the south-west, a condition favourable to increasing the height in the Channel; it then flew round to the north-west, a quarter which always raises the tide in the North Sea. The combined influence of the winds from these two opposite quarters would therefore tend to concentrate the full effect of the tide along the south-eastern coast, and the records of the damage done to the cliffs and in flooding, owing to the water breaking through or flowing over the banks, and doing other damage, show that this was the case. Fortunately the gale occurred five days after the new moon, or the effect would have been even more serious. The amounts by which the water at a few places rose above the proper tide-mark on Monday, November 29, are as follows:—Grimsby, 5 feet 11 inches; Hull, 5 feet 3 inches; The Wash (Boston Dock), 5 feet 3 inches; Lynn, 7 feet; Yarmouth, 8 feet; Ipswich, 6 feet 6 inches; Dover, 6 feet 1 inch; Gravesend, 3 feet 4 inches; Newhaven, 2 feet 4 inches; Portsmouth. 1 foot 8 inches.

THE last published *Annali* of the Italian Central Meteorological Office contains particulars of the activity of that department in various directions. One section deals specially with agricultural meteorology and the distribution of thunderstorms, and publishes a monthly review containing ten-day means for a considerable number of stations. A regular discussion of the mean weekly and annual frequency of thunderstorms and hail has been undertaken, and the results for some provinces have been laid before the Royal Academy. Another section deals specially with earthquakes, and the observations are regularly published in a monthly *Bulletin*. Dr. Agamennone, to whom we are indebted for many researches in this subject, has established a geodynamic observatory at Constantinople, with instruments similar to those in use at Rome. Considerable attention is paid to terrestrial magnetism, and the present volume contains an account of the absolute measurements of the different magnetic elements made in Italy in the years 1888-9. Among the purely meteorological discussions we may mention one on the anemometrical records at Vicenza for the fifteen years 1875-90. The author states that the diurnal velocity curve is far from showing the simplicity of a single diurnal wave.

THE properties of algebraic curves, classified on the basis of their gonality, have been studied by Prof. Amadeo, and a paper on the subject—the third of a series—is published in the *Rendiconto* of the Naples Academy (iii. 3a, 8-10). After dealing at length with the k-gonal curves of the first and second species, the author passes on to consider those of species s. The most noteworthy feature is the proof that a k-gonal curve of species s can be referred uniquely to a k-gonal curve of the first or second species, according as s is odd or even.

THE *Botanical Gazette* for November prints a very interesting history of the public gardens and plantations in Jamaica, contributed to the *Proceedings* of the Botanical Society of America by Mr. W. Fawcett, the Director. The first Botanic Garden in Jamaica was formed about 150 years ago by a private individual, Mr. Hinton East, on his property near the present village of Gordon Town, nine miles from Kingston. It was

shortly afterwards taken over by the Government, and two gardens established, a "European" and a "Tropical." But it was only within about the last thirty years that a serious attempt was made, under Sir J. B. Grant, to make the Gardens of economic value to the Colony, during which time much has been done to determine what foreign importations are most suitable to the climate. There are now six larger or smaller Gardens, viz. the Parade, King's House, Hope, Hill, Castleton, and Bath Gardens, varying greatly in their climatal conditions. Mr. Fawcett estimates that the native flora of the island includes about 450 ferns, and 2180 species of flowering plants.

ATTENTION has been previously called in our columns to Prof. Felix Plateau's observations of the way in which flowers attract insects (*Bulletin de l'Académie Royale de Belgique*), from which he inferred that the presence or absence of brightly-coloured corollas possessed little or no influence on their insect visitors. These researches are concluded in the current number of the *Bulletin* (iii. 34). Repeated experiments on seventeen species of plants, all genuinely anemophilous, prove that it is sufficient to place on the greenish or brownish inconspicuous flowers some artificial nectar, represented by honey, in order to attract numerous insects. Moreover, it appears (both from the author's personal observations and from previous writings) that insect visits, often frequent, have been observed on ninety-one forms of entomophilous plants having flowers devoid of conspicuous colour, viz. forty-one with green, thirty-eight with greenish, and twelve with brown or brownish flowers. The author has verified the coloration for seventy-two of these plants, and has himself observed the visits of insects to sixty-three, or more than two-thirds of them. Prof. Plateau concludes that insects are little affected by the presence or absence of brilliantly coloured floral organs; what they seek is the pollen or nectar, and in finding these their sense of vision is merely accessory; while, on the other hand, they are guided with certainty by some other sense, which can only be that of smell.

AN important series of investigations has recently been published in the *Annales de l'Institut Pasteur*, by Dr. Paul Remlinger, on the artificial communication of typhoid fever by the alimentary tract. Hitherto it has been customary to infect animals with the typhoid bacillus by introducing this organism into the peritoneum, but in consequence of the attention which has lately been directed to the danger of typhoid being disseminated through the direct watering of vegetables with sewage, Dr. Remlinger experimented on the possibility of infecting rabbits and rats with typhoid by feeding them on vegetables soaked with typhoid bacilli. These experiments showed that it was possible to induce typhoid fever in rats and rabbits by this means, and Chantemesse has not only confirmed Remlinger's results, but states that he has succeeded in infecting monkeys with typhoid in a similar manner. The following experiment gives some idea of the results obtained by Remlinger in this interesting inquiry. A rabbit commenced to eat typhoid-soaked vegetables on August 30; two days later its temperature rose and later on it became thin and apathetic, and on September 7 the supply of typhoid bacilli was stopped; on September 15 symptoms of diarrhœa made their appearance, and blood taken from the animal gave a positive reaction with the sero-typhoid test; a few days later the temperature became normal, and the animal gradually recovered, but on September 30 its blood still gave a positive reaction with the above test. Experimental typhoid induced in this manner in rats resembled very closely the symptoms observed in the case of rabbits. It is, however, necessary in order successfully to infect animals with typhoid by this means, to make them frequently swallow large quantities of the bacilli.

THE number of *Isis* (Dresden) for the first half of 1897 contains a paper, by Dr. P. Menzel, on the "Tertiary Flora of the 'Jesuitengraben' at Kundratitz," a very rich layer, from which a number of new species are described. A plate accompanies the paper.

THE Report of the Director of the Botanical Survey of India for 1896–97 includes reports from all the Directors of Departments except that of Southern India. The results will shortly be dealt with of the botanical exploration, by Lieut. Pottinger, of a portion of the valley of the Irrawaddy, a country hitherto absolutely unknown. A synopsis is given of the flora of Western India as far as the Tiliaceæ.

THE Tuesday evening science lectures at the Royal Victoria Hall, Waterloo Road, during January, will be as follows:—January 4, "Coal," by Mr. W. F. Rudler; January 11, "Diamonds," by Prof. H. A. Miers, F.R.S.; January 18, "Through the New Gold Fields of Alaska to Bering Strait," by Mr. H. de Windt; January 25, "Mars as a World," by Mr. R. A. Gregory.

PHILIP'S revolving planisphere is well known to be a very handy and serviceable means for finding the constellations visible at any time. A more substantial form of the contrivance, with an adjustable calendar combined, has just been published by Messrs. George Philip and Son. The arrangement is made so that it will stand alone, or it may be hung from a wall. It is thus a suitable ornament for the astronomer's desk, or for the observatory.

THE additions to the Zoological Society's Gardens during the past week include a Mandrill (*Cynocephalus mormon*, ♂), a Mona Monkey (*Cercopithecus mona*, ♂), two Green Monkeys (*Cercopithecus callitrichus*, ♂ ♂), a —— Hawk Eagle (*Spizaetus* ——), seven African Walking Fish (*Periopthalmus koelreuteri*) from West Africa, presented by Dr. H. O. Forbes; a Sykes Monkey (*Cercopithecus albigularis*, ♂) from West Africa, presented by Mr. Henry Curnow; a Binturong (*Arctictis binturong*) from Malacca, presented by Mr. W. W. Skeat; a Blotched Genet (*Genetta tigrina*) from South Africa, presented by Mr. J. E. Matcham; a Ruddy Ichneumon (*Herpestes smithi*) from India, presented by Colonel F. Morison; two Grey Struthideas (*Struthidia cinerea*) from Australia, presented by Mr. R. Phillipps; a Crimson-eared Waxbill (*Estrelda phœnicotis*) from West Africa, presented by Miss Aves; a Thar (*Capra jemlaica*, ♂) from the Himalayas, six White Pelicans (*Pelecanus onocrotalus*) from Egypt, deposited; three Coscoroba Swans (*Coscoroba candida*) from Antarctic America, a Macqueen's Bustard (*Houbra macqueeni*) from Western Asia, purchased.

OUR ASTRONOMICAL COLUMN.

NEW DOUBLE STARS.—The discovery of new double stars at the Royal Observatory, Cape of Good Hope, by Mr. R. T. A. Innes, is proceeding apace, and Dr. Gill publishes in *Astr. Nach.*, 3462, a fourth list of such objects. The number of stars given is twenty-nine, making the total now discovered 259. The distances of the components range in this last list from 0″·5 to 5″.

NEW VARIABLE STARS.—More than once in this column it has been shown that useful astronomical work can be done with instruments of only moderate size, backed up by steady observation; but no one has done more to emphasise this fact than Dr. Anderson, of Edinburgh, first with his discovery of Nova Aurigæ, and later by a close scrutiny of stars to detect any variability. From observations made with his 2¼-inch refractor, he points out in *Astr. Nach.*, 3461, that a star in Aquila, not mentioned in the Bonn *Durchmusterung*, but whose position (possibly wrong to the extent of 1′) is R.A. 19h. 31m. 10s. Decl. + 11° 23′, has proved to be variable

Again, in *Astr. Nach.*, 3463, he gives notice of two new variables—probably of short period—B.D. + 67°·1124 in Draco, and B.D. + 30°·1329 in Gemini, with respective positions: R.A. 19h. 9m. 54s., Decl. + 67° 2′·4, and R.A. 6h. 37m. 50s., Decl. + 30° 25′.

All the positions are given for the epoch 1855.

VARIATIONS IN THE SPECTRUM OF NEBULA IN ORION.—Often has severe criticism put scientific facts on a firmer basis, and such might be said to be the case with Dr. Scheiner's doubts concerning Prof. Campbell's observed variations in the spectrum of different regions in the Orion nebula, made in 1893. To test the accuracy of some specific observations, Prof. Campbell has called in the assistance of three of his colleagues (Prof. Schaeberle amongst them), and, with the aid of the 36-inch refractor and an efficient spectroscope, different regions of the nebula have been examined to observe the behaviour of the three principal nebular lines.

The mode of making the observations was to use a coarse micrometer wire, occulting each of the lines in turn, so as to determine the relative brightness of the remaining two, when all three are observable.

The following are the results, which in the main all the observers are agreed upon:—Central part of nebula (Trapezium region): the three nebular lines all conspicuous, the line λ 5007 being the brightest, whilst the lines λ 4959 and λ 4861 are nearly of the same intensity as each other.

In the region surrounding the star Bond, No. 734, the line λ 4861 was the only one visible, the other two lines having disappeared; whilst in the region south-west of the Trapezium all three are visible, but the line λ 4861 is still the brightest.

No doubt photographs will be secured whilst Orion is well situated, and so further establish these observations made visually.

WINNECKE'S PERIODIC COMET.—One is reminded on reading the life-work of the late Dr. Winnecke, in the last number of NATURE, that had he lived a few weeks longer he would probably have seen another return of the periodic comet which bears his name, for it is due at perihelion on March 20, 1898, but of course will be better situated for observation some time before this. The elements and ephemeris as given by Mr. C. Hillebrand in *Astr. Nach.*, 3447, are as follows:—

Elements.

	26 October. 1897.	15 March, 1898.	
	° ′ ″	° ′ ″	
M =	325 24 26·7	359 3 52·0	
π =	274 14 33·3	274 14 39·0	1900
Ω =	100 53 34·3	100 53 11·5	1900
i =	16 59 34·4	16 59 33·8	1900
φ =	45 37 35·6	45 37 14·7	
μ =	608″·3483	608″·5559	

Ephemeris.

1897-98.	R.A. h. m. s.	Decl. ° ′	log r.	log Δ.	1 : $r^2\Delta^2$.
Dec. 21	14 38 14	− 1 6·6	0·19028	0·28225	0·113
25	51 6	2 2·3	17921	26885	127
29	15 4 28	2 58·6	16788	25550	142
Jan. 2	18 24	3 55·3	15629	24228	160
6	32 53	4 52·3	14446	22929	179
10	15 47 58	5 49·3	13242	21659	200
14	16 3 40	6 46·1	12016	20432	224
18	20 0	7 42·1	10773	19259	251
22	36 59	8 37·0	09518	18151	280
26	16 54 36	9 30·3	08256	17122	311
30	17 12 49	10 21·3	06993	16184	344
Feb. 3	17 31 41	− 11 9·0	0·05738	0·15349	0·379

The best time for making a search will be early in the morning, shortly before sunrise, from about now till early in February. The comet is never visible to the naked eye, and will at first be faint with the aid of a telescope; its apparent path is in a south-easterly direction through Virgo, Libra, Scorpio, Sagittarius, and Capricorn.

KEKULÉ MEMORIAL LECTURE.

AT an extra meeting of the Chemical Society, held on Wednesday, December 15, Prof. F. R. Japp, F.R.S., delivered a memorial lecture in honour of the eminent German chemist, Friedrich August Kekulé, whose death occurred in July 1896. The lecturer said that Kekulé's supreme merit lay in his contributions to theoretical chemistry. His greatest achievements in this department were the doctrine of the linking of atoms in terms of their valency, and, growing out of this, the theory of the structure of organic molecules, both in open-chain and in closed-chain compounds. These were not recondite theories, hidden away in the depths of the science; they were organic chemistry itself, and were learnt by students on their first introduction to the subject. Kekulé acknowledged that his theories were based on Gerhardt's type theory, on Williamson's theory of polyvalent compound radicles and multiple types, and on Odling's theory of mixed types, which was a deduction from Williamson's theory. Less consciously, perhaps, his opinions were influenced by E. Frankland's theory of the valency of elementary atoms, and by Kolbe's speculations on the constitution of organic compounds. Kekulé developed these ideas, which he found scattered throughout the writings of his predecessors, added to them, and welded the whole into the coherent system which formed our present theory of the structure of organic compounds. In Kekulé's model of the carbon atom "the four units of affinity," to quote his own words, "radiate from the sphere representing the atom so that they end in the faces of a tetrahedron." This model was destined to play an important part in the development of theoretical chemistry; it was the foundation of stereochemistry. Kekulé's benzene theory was the crowning achievement, in his hands, of the doctrine of the linking of atoms; it was the most brilliant piece of scientific prediction to be found in the entire range of organic chemistry. What Kekulé wrote in 1865 had since been verified in every essential particular. Not only had the various substitution derivatives been discovered in the number and with the properties required by the theory, but various observations which appeared to contradict this theory had been proved erroneous. Moreover, the theory had shown itself to be capable of boundless development, and there seemed to be no limit to the fruitfulness of Kekulé's conception of closed chains or cycloids. The extensions of the idea, of which extensions Erlenmeyer's naphthalene formula and Dewar's formulæ for pyridine and quinoline were among the earliest instances, had gone on increasing in a rapid geometrical ratio, until, at the present day, the literature dealing with cycloids, although of so recent growth, was more than twice as voluminous as that of the paraffinoids. But even in the undeveloped state of the subject prior to Kekulé's theory, the facts were apparently so inintricate and so unconnected that few chemists could claim to have mastered them. The theory appeared; the previously unmarshalled facts fell into their proper places; and not only this, but it was possible to say whether, in any given section of the subject, the facts were complete or only fragmentary. The debt which both chemical science and chemical industry owed to Kekulé's benzene theory was incalculable. As regards the former, three-fourths of modern organic chemistry was, directly or indirectly, the product of this theory; and as to the latter, the industries of the coal-tar colours and the artificial therapeutic agents, in their present form and extension, would be inconceivable without the inspiration and guidance of Kekulé's fertile idea. By the accuracy of his predictions he had done more to inspire a belief in the utility of legitimate hypotheses in chemistry, and had therefore done more for the deductive side of the science than almost any other investigator. His work stood pre-eminent as an example of the power of ideas.

RECENT RESEARCHES ON TERRESTRIAL MAGNETISM.[1]

II.

UP to this point we have regarded the system of magnetic forces in play upon the surface of the earth as constant. I have already hinted that this is not the case, and that the difficulties of our investigation are immensely increased by the fact that all the phenomena with which we deal are in a state of flux. Nothing is fixed from year to year, from day to day, from hour to hour. It is hardly too much to say that at times almost every minute brings with it changes which it is the business of the magnetician to investigate and explain. For the moment, however, I wish to fix attention only upon the secular change to which I have already referred. Not only does the angle which the magnet makes with the geographical meridian vary, but the dip also increases and diminishes in turn.

[1] The "Rede Lecture" delivered in the Senate House, Cambridge, on June 9, by Prof. A. W. Rücker, F.R.S. (Continued from p. 163.)

An interesting method of depicting these changes has lately been suggested by Dr. Bauer. He imagines the observer to be stationed at the central point of a magnet suspended so that it can turn freely in any direction. To a person thus situated, and capable of continuing his observations through periods far exceeding the range of human life, the north pole of the magnet would appear to describe a curve. It would move sometimes to the right, sometimes to the left, and would simultaneously rise or fall. The facts which have been observed during the last 150 years, and, in some places, for longer periods enable us to draw these curves. At the great majority of the places first

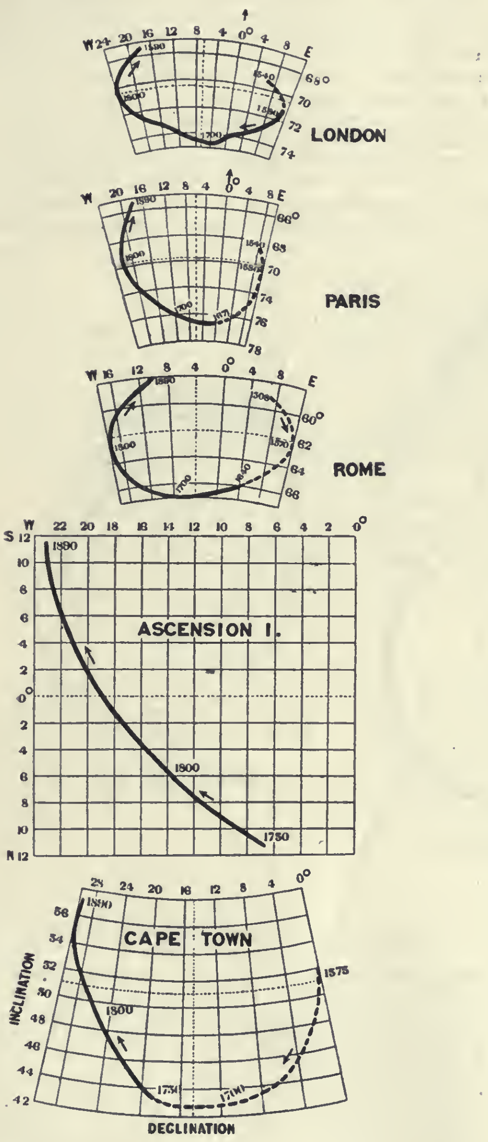


FIG. 3.

investigated the pole of the magnet would always appear to the observer to describe its orbit in the same direction as the hands of a watch, so that on the whole when the needle was to the east of its mean position it would generally be falling, and when to the west rising. Unfortunately, however, this statement is not of universal application, as there are a certain number of stations on the west coast of America where the ordinary movement appears to be reversed. If figures representing a number of these magnetic orbits are arranged, in order from north to south, as in Fig. 3, and if those selected are appropriate to places the longitude of which is not very far distant from that of Greenwich, it is found that in passing from north to south the area enclosed by the figure becomes larger, and that it again diminishes when the equator is passed. In other words, for these stations the rule holds good that the orbital sweep of the needle is greatest near to the equator. There is an-another curious peculiarity, namely that for stations of approximately the same latitude in the northern and southern hemispheres, respectively, the curves are larger in the Southern Hemisphere.

If, however, we turn to the American continent, the curves are different, the range of declination is less, and the figures, instead of being of an approximately circular form, become elliptical.

In no case have the phenomena been registered for a sufficiently long time to enable us to complete any one figure. For London we have fairly accurate data for about three centuries, and the earlier observations enable us to extend the curve still further backwards with some probability of accuracy. In the case of our own country we have probably followed the movement of the needle from an extreme easterly position attained in the time of Elizabeth to an extreme westerly position which was reached about 1824, but we have no right to assume that the return journey from west to east will occupy the same time as that which has been watched from east to west.

The first conclusion, then, which I wish to draw from these figures is that they and others like them display what is practically the whole of our knowledge as to the time during which magnetic phenomena go through a complete cycle of change. Calculations have been given by high authorities, which lead to the conclusion that the magnetic pole would perform an orbit round the pole of the globe in about 960 years; but a glance at the curves is sufficient to show how uncertain are the data upon which such estimates are based.

The speed with which the secular orbit is described does not appear to be constant. It may be more or less rapid in the future than in the past. The curves, though so far smooth and continuous, may in the future develop loops or irregularities of various kinds. We may doubt whether all the orbits are described in the same time. It is quite possible that the paths may not return into themselves, or be repeated in successive cycles.

These difficulties may be illustrated by another suggestive device of Dr. Bauer's. Let us suppose for a moment that the principal part of the magnetic system of the earth consists of forces due to currents or magnetic matter which are unchangeable and are arranged symmetrically with respect to the geographical axis. Let there be superimposed upon this another magnetic system describing within the earth and around the geographical axis an orderly orbit completed in an unknown term of years. Let us further suppose that this second system is itself unalterable except in position, so that, as it revolves, the magnitude of the forces is unchanged though the position of the points from which they emanate varies. Under these circumstances we should be able to foretell from the present state of the earth what the future cycle of change would be. If the magnetic needle were placed at some fixed point on the surface of the earth, it might take hundreds of years for the revolving magnetic system to make one complete revolution so as to take up every possible position with regard to the needle. But if the needle were suspended like Mahomet's coffin near to the surface of the earth, and were held there while the globe rotated beneath it, then in a single day the relative positions of the revolving magnetic system and the suspended needle would undergo every possible change, and the pole of the needle would describe in twenty-four hours the path which may in reality be accomplished in a millenium.

Of course we cannot thus suspend a magnet in space, but the same end would be attained by carrying it round the globe along a parallel of latitude, and we have sufficient knowledge of the magnetic conditions of the surface of the earth to determine the curve which the pole of the needle would describe during such a journey.

Three of these curves have been drawn by Dr. Bauer for the equator and for latitudes 40° N. and 40° S., and a glance at the diagram on which they are depicted shows that though they are larger, they bear a general resemblance to the secular curves which portray the movements of the needle at various stations near to the prime meridian. In particular the curious difference in the size of the orbits for equal latitudes north and south of the equator respectively is reproduced. Dr. Bauer has drawn curves for three different dates, of which only those correspond-

ing to two are here reproduced (Fig 4), and of course, if the basis of our argument were unimpeachable, they should be identical. This is not so; there are noticeable, although not very great, differences, but, together with other facts already mentioned, the variations are sufficient to enable us to affirm that the secular change cannot be deduced in this simple fashion from the present magnetic state of the earth.

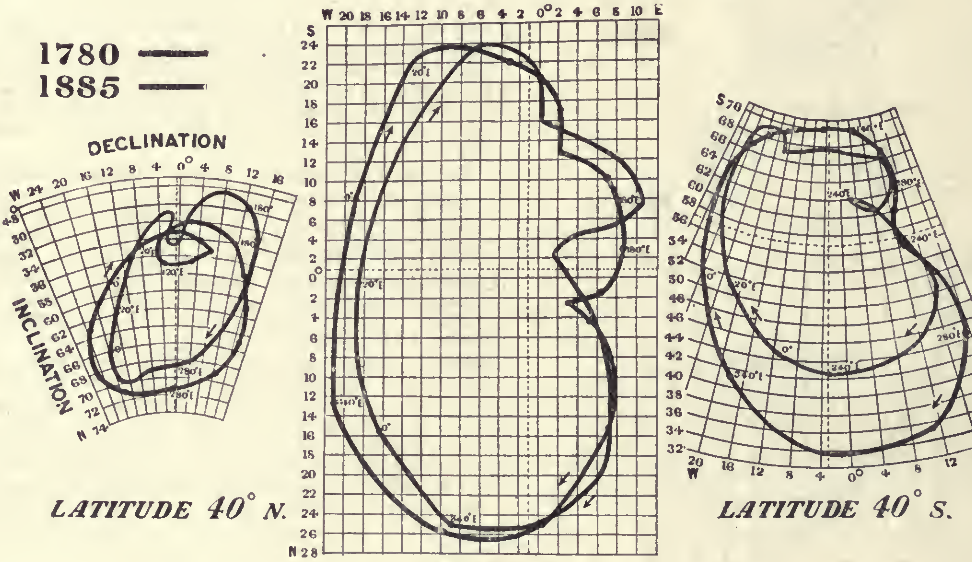
There is one other point with regard to the curves which shows how great must be our caution in arguing from such data. In the lower parts there is a general similarity with the curves deduced from past observations with the magnet at different places near the prime meridian, but in the upper portions, which refer to the future, the curves are more complicated, and they are varied by irregularities and loops of which we have, as yet, had no actual experience. Dr. Bauer has observed most praiseworthy caution in deducing any definite conclusions from these interesting speculations. But even if we refuse to accept his hypothesis that there is a more than accidental connection between the secular curve which the pole of the magnet describes at any one place, and the curve which it would describe if carried round the earth in the latitude of that place, there can be no question that it is possible that irregularities similar to those seen in the one set of curves may in the future occur in the others, and that any deduction which we may make as to the period of the magnetic cycle from the past, may be woefully falsified by future events.

It is instructive to compare with this speculation the results obtained by Captain Creak from a comparison of the maps of the magnetic state of the earth drawn by General Sabine and those which Creak himself elaborated with the aid of the observations made by the *Challenger* expedition. The conclusion to which he came was that during the forty years which elapsed between the epochs for which the maps were drawn, the secular change might be best represented by supposing that the magnetic poles were stationary, but that at certain points on the surface of the earth the forces of terrestrial magnetism had been increasing or diminishing. I have before now referred to these interesting observations in public, and I will not dwell on them again, except to remark it is possible that we may have to deal with causes both of the one type and of the other, that within the earth there may be a rotating magnetic system, and that purely local causes may also alter the intensity of the magnetic forces at different places.

Dr. Schuster has recently shown that a motion of the magnetic pole might be produced if the space round the earth were conducting. The conditions under which this would occur cannot be discussed now, but the magnetician has reason to be grateful for any hint as to a possible physical explanation of the secular change.

In addition to the long-protracted changes which have been discussed, the pole of a freely-suspended magnet also describes an orbit from day to day, which is so small, when compared with the secular path, that hitherto I have neglected it. This diurnal change has long been studied. Its magnitude varies from time to time and has been found to be connected with the season of the year and with the sunspot period. On these comparatively well-known facts I will not dwell, but there is one point in connection with the diurnal variation which has recently been attracting attention. For days together the orbits described may be very similar, but this regular motion is frequently disturbed by violent perturbations, and the pole of the magnet moves within a few minutes both to the west and to the east to an extent far exceeding that due to the ordinary diurnal motion, so that the form of the path is widely irregular. Such a phenomenon is called a magnetic storm, and from the fact that such storms occur simultaneously at places which are widely distant it has been thought that it is possible that they are due to some impulse which reaches the earth from the sun. They are also closely connected with displays of the Aurora Borealis. These irregularities make it difficult to determine what is the true normal behaviour of a freely suspended magnet. The most obvious plan for determining the average movement of the needle is to take the mean of its positions at each one of the twenty-four hours for every day in the year. The disturbances just referred to will thus be included in the calculations, but as very great magnetic storms are comparatively rare, the final value will not be very largely affected. This process is very laborious, and exceeds the powers of any except the best equipped observatories. Some time ago, therefore, it was suggested that the calculations should be shortened by the selection of quiet days only, on which it was to be supposed that the behaviour of the needle was normal. Five days in each month were considered sufficient, and by a happy arrangement all the English observatories have agreed that these days shall be chosen by the Astronomer Royal, and that thus the determination of the normal movement of the needle shall be made by all of them from data collected at the same time.

Attention has recently been drawn to the fact that, whatever the convenience of this five-day method may be, it leads to the conclusion that at the end of a quiet day, the needle does not return to the position which it occupied at the beginning. This point has been carefully investigated by Dr. Chree, and may be illustrated by means of the curve which I have drawn from the Kew Observatory Report for the summer of 1895, the scale of



EQUATOR.

FIG. 4.

which is many times larger than that of the secular orbits already depicted (Fig. 5). The upward and downward movement of the needle is much smaller than the displacement east and west, so that an elongated figure is produced, but the interesting point is that it is not a closed curve; the two ends do not meet, but are separated by a very appreciable interval. It would, of course, be an easy explanation of this fact, if we could attribute it to the secular change. Just as the moon, though at the end of a month in the same position with respect to the earth as it was at the beginning, is much further advanced in the earth's orbit, so the diurnal magnetic variation must accommodate itself to the larger secular movement of which it is a subordinate part. But this explanation alone will not suffice. It is true that during the quiet days the movement of the needle in its secular path continues, but there is a good deal of evidence to show that it is of more than average speed. This is especially true of the horizontal force, which is gradually increasing and increases with remarkable rapidity on quiet days. Hence the secular movement appears to be checked by the storms. The comparatively rapid progress which has been made in quieter times, being retarded and even reversed during the periods of irregular motion which I have described.

It is true that General Sabine many years ago showed that magnetic storms do not act equally in both directions upon the needle, and that thus the phenomena which I am now describing can hardly be said to be recently discovered; but the method of presenting it which has been adopted by Dr. Chree, and which I have slightly modified by including in the diagram the variations both of declination and of dip, certainly places the facts before us in a novel and a striking light. Of what the cause of the sudden check which the needle receives during the magnetic storms may be, we can as yet say nothing. It is one of the puzzles which has yet to be unravelled.

The last point to which I will refer is one upon which more definite results have been obtained. Terrestrial magnetism is

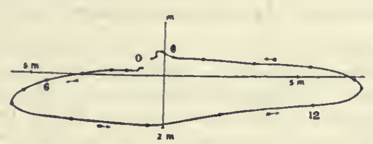


FIG. 5.

connected with phenomena which occur in the sun, with the Aurora Borealis in the upper atmosphere, and with the earth currents which traverse the soil. I have now to draw your attention to its relation to geology.

It has long been known that just as the great secular variation of the magnet is accompanied by minor diurnal changes, so the large alterations in the direction of the compass and dipping needle, which are observed when we move from place to place on the surface of the earth, are affected by irregularities which are apparently due to purely local causes. Thus the declination is greater in Ireland than in England; but the increase is not uniform as we pass from one country to the other. In fact in some districts an abnormally large increase is followed by a decrease.

These curious inequalities must be due to local disturbing forces, and the large number of observations which have been made in this country have enabled us to determine with more than usual accuracy the magnitude and direction which the magnetic forces would assume if they were undisturbed by any local cause, and from the difference between things as they then would be and things as they actually are, we can calculate the magnitude and direction of the disturbing forces themselves. When these are represented on a map, it is found that there are large districts of the country in which the disturbing horizontal forces act in the same direction; in one region the north pole of the needle will be deflected to the east, in another to the west, and, as we pass from one of these districts to the other, we always find that at the boundary the downward vertical force on the north pole of the needle reaches a maximum value. We are thus able to draw upon the map lines towards which the north pole of the needle is attracted. It is found that the exact position of these can be determined with considerable accuracy, and that the lines can be traced without any possible doubt through distances amounting, in some instances, to a couple of hundred miles. The key to this curious fact is probably furnished by observations in the neighbourhood of great masses of basalt or other magnetic rocks. If these were magnetised by the induction of the earth's magnetic field, the upper portions of them would in this hemisphere attract the north pole of the needle; and it is found that where large masses of basalt exist, as in Antrim, in the Scotch coal-fields, in North Wales, and elsewhere, the north pole of the needle is, as a matter of fact, attracted towards them from distances which may amount to fifty miles. The thickness of the sheets of basalt is in most cases too small to furnish a complete explanation of the observed facts, but it is quite possible that these surface layers of magnetic matter are merely indications of underground protuberances of similar rocks from which the surface sheets have been extruded. At all events, there is no possible doubt of the fact that where large masses of basalt occur, the north pole of the needle tends to move towards them.

There are other regions where the attractions are manifest, but where, nevertheless, no magnetic rocks occur upon the surface; but it is most probable that the cause is the same, and that it is due to the mere accident of denudation that in one case we can, and in the other we cannot, point to the magnetic rocks to which the anomalous behaviour of the compass is due. If this be so, it is certainly interesting that magnetic observations should enable us to penetrate to depths which the geologist cannot otherwise reach, and that the lines which we draw upon the surface of the map, as those to which the north pole is attracted, may, in fact, roughly represent the ridge-lines of concealed masses of magnetic rocks, which are the foundations upon which the deposits studied by the geologist have been laid.

There is some ground for thinking that if these great underground wrinkles exist, they have affected the rocks which are superposed upon them, especially those which are of a comparatively early date. As a general rule, if older rocks appear in the midst of newer ones, the pole of the magnet will be attracted towards the protruding mass; but this rule holds good only of the rocks of carboniferous or pre-carboniferous age, and does not apply to later deposits. As a striking example, I may remind you that the Pennine Range—which is sometimes called the "Backbone of England"—is a mass of millstone grit rising amid younger rocks. Down this a well-marked magnetic ridge-line runs. Similarly, in the neighbourhood of Birmingham, the Dudley and Nuneaton coal-fields are surrounded by more modern deposits. A curious horse-shoe shaped ridge line connects these two, and then runs south to Reading, which is, magnetically speaking, one of the most important towns in the kingdom. East and west from Dover to Milford Haven, and then across the Irish Channel to Wexford, runs a ridge of the older rocks called by geologists the Palæozoic Ridge, concealed in many places by newer deposits. Hollowed out in this are the South Wales and Forest of Dean coal-fields, and in another hollow within it lies the coal which has recently been discovered at Dover. Closely following this protruding mass of the older rocks is a magnetic ridge-line which passes through Reading, and we thus have a magnetic connection between the anticlinals of Warwickshire and the Palæozoic Ridge. From the neighbourhood of Reading also another magnetic ridge-line runs southwards, entering the channel near Chichester. M. Moureaux, who with most untiring energy has for many years been investigating single-handed the magnetic constitution of France, has discovered the continuation of this line on the French coast near Dieppe, and has traced it through the north of France to some fifty miles south of Paris. The energy which is now being displayed by magnetic surveyors in many countries will, no doubt before long, prove that the network of these magnetic ridge-lines is universal; and the relations between them and the geological conformation of the countries in which they lie will be so studied that our inductions will be based upon an adequate knowledge of facts.

This, at all events, we may hope, that amid the flux and change of magnetic forces with which we have so largely been occupied, we may have found in these ridge-lines physical features of the country as permanent as the hills themselves.

And now that I draw near to the end of my lecture, I cannot but feel that it has to a certain extent been wanting in organic unity. It is sometimes possible to unfold the story of a scientific advance in strictly dramatic form. The question posed, the oracle consulted, and the answer given, might well form the titles of the three acts in the modern miracle-play of scientific discovery. But the drama has its conventions, and even those authors who boast of their realism, too often falsify by over-

emphasising the points on which they chiefly dwell. If we would know life we must learn it not from the stage-box or dress circle, but by mingling with mankind. If we would know what scientific work is, we must not be content with listening only to skilfully-told tales of scientific triumphs, but must penetrate into the observatory or laboratory, where the fear of failure, and the uncertainty of long watching and waiting, are at least as frequent visitors as the assured forecast of success.

To-day, therefore, I have dealt with problems which are still surrounded by doubt and difficulty, with questions which can only be answered by the combined work of many men, it may be of many generations. It is true that on some of these matters we are gradually acquiring definite knowledge. That earth-air currents, if they exist at all, are very minute in north-western Europe; that the diurnal variation on quiet days is not necessarily to be regarded as normal; that local magnetic disturbances are due to forces so wide in their range that it is worth while to study them; these are all facts about which we were in doubt a few years ago, and on which we are in doubt no longer. But greater questions which lie behind these are still unanswered, and if I have ventured to deal with difficulties as well as with certainties, it has been because I have wished to give you a correct idea of current scientific thought on the subject of terrestrial magnetism.

MR. MERRIFIELD'S EXPERIMENTS ON THE RELATION OF TEMPERATURE TO VARIATION.

FOR the last ten or eleven years Mr. Frederic Merrifield, of Brighton, has been conducting a most elaborate and extensive series of experiments in the rearing of lepidopterous insects under various conditions of temperature. The results obtained by him are of high interest, both in themselves and also in reference to similar experiments independently undertaken by Dorfmeister, Weismann, Standfuss and others, some of which have already been noticed in the pages of NATURE. It is proposed to give here a short general account of the chief of Mr. Merrifield's experiments, with figures of some of the main results obtained. For full details the reader is referred to the original accounts which have appeared from time to time in the *Transactions* of the Entomological Society of London.

Experiments in 1887.—The first experiments undertaken had the object of supplying data for an inquiry by Mr. Francis Galton on the subject of heredity. It was anticipated by Mr. Galton that "the experiments would elicit incidentally many interesting results, some perhaps quite disconnected with the objects immediately in view." This anticipation was fully borne out by the facts.

The first species taken for experiment were two geometer moths, *Selenia bilunaria*, Esp. (*illunaria*, Hb.), and *S. tetralunaria*, Hufn. (*illustraria*, Hb.), both normally double-brooded in this country. Larvæ of both species were reared from eggs laid by females of the spring emergence; some of the moths resulting from these were selected for pairing according to size, three classes being formed, of maximum, medium and minimum expanse of wing, and the rearing of fresh generations was continued. Some of both species were fed up in the open air; these showed nothing remarkable. Others (of *S. bilunaria*) were kept during all their stages at a temperature of about 80° F., which had the effect of considerably accelerating their development. Five generations of *S. bilunaria* (counting the moths of the spring emergence as the first generation) were thus produced in the course of the year. These bred moths were all of the summer or *juliaria* form, and the females were always larger than the males, which is in accordance with the rule for the natural summer brood. The pairs selected for maximum and minimum expanse of wing produced no fertile eggs after the third generation. The fourth generation consisted entirely of the offspring of one of the medium-sized pairs of the third, and from these a selection was again made as before. The resulting moths of the fifth generation emerged in December and January, showing signs of deterioration. Only one of this brood laid fertile eggs, and these failed to hatch. The average size of the moths increased continuously up to the fourth, but diminished in the fifth generation.

Experiments in 1888.—The summer of 1888 was cold and wet, and the moths of both the selected species reared from larvæ kept in the open air showed signs of degeneration. That this was not due to the domestication of their progenitors appeared from the fact that a wild strain of *S. tetralunaria* behaved in the same manner.

It was observed in the case of *S. bilunaria* that the specimens produced from larvæ and pupæ that had been kept at about 80° F. showed a warmer colouring and fewer spots than those reared throughout their stages at ordinary temperatures. The same was found to be true in a still more marked degree of another species of geometer moth, *Ennomos autumnaria*, Wernb., and also, though to a less extent, of *S. tetralunaria*.

Experiments on the pupæ of *S. tetralunaria* led to interesting results. It was found that moths derived from pupæ of the summer brood, first retarded in development by freezing, though ultimately forced for a few days, tended, especially in the females, to assume the appearance of the comparatively dark spring emergence. Some larvæ of the same summer brood and their resulting pupæ were forced from the beginning, with the result that the same batch split into two divisions, the first of these feeding up rapidly and emerging, during the same season, with the summer colouring; the second taking much longer, and attempting to lie over for the winter as pupæ. A continuance of the forcing process brought out some of the latter in November and December, with the summer colouring. Others were exposed out of doors from November 7 to January 1, when they were brought into the house and again forced. The moths from this latter group came out in January and February, and were all of the spring colouring. Inasmuch as the continuously forced batch gave the summer form as late as December, it would appear that retardation alone is not in all cases sufficient to determine the assumption of the spring coloration. On the other hand, some pupæ of *S. tetralunaria* reared by Mr. Jenner, which were similarly trying to lie over for the winter, produced under forcing a series of intermediate forms becoming on the whole more and more like the spring type with the length of time that elapsed before their emergence. Here there was no exposure to winter cold; but only retardation from constitutional causes.

Mr. Merrifield remarks that the case of *S. tetralunaria* shows that the alternate succession of the two forms is not a necessary accompaniment of seasonal dimorphism. The same appears from Weismann's earlier experiments, in which, under appropriate conditions of temperature, the summer form *Vanessa prorsa*, L., was found to give rise in the next generation to *V. prorsa* instead of to *V. levana*, L. (the spring form).

The different reaction of members of the same brood of *S. tetralunaria* to the same conditions of temperature is interesting as an example of what may perhaps be called "physiological dimorphism"—a principle which there is reason to think is widely prevalent in nature, and which probably favours the survival of those species that exhibit it.

Experiments in 1889.—These had two main objects, the first being to determine the amount of exposure to cold that could be borne in the different stages, the second to ascertain more definitely the effect upon the perfect insect of temperature conditions applied during the immature periods.

Under the first head it was found that the eggs of both species of *Selenia* were injured by protracted icing; a temperature of 80° to 90° F., on the other hand, did no harm and quickened their development. Some eggs of *S. tetralunaria* gave another good example of physiological dimorphism. Thirty eggs were iced for seventeen days. On their removal from the ice-box, two hatched at once; none of the rest yielded larvæ until from eleven to thirteen days afterwards, when nineteen of them also hatched.

Icing the larvæ of *S. tetralunaria* was found to be rapidly fatal, and cooling injurious. The older larvæ stood cold better than the young ones. Larvæ of *S. bilunaria*, *S. tetralunaria*, *E. autumnaria* and *E. alniaria*, L., all endured a continuous temperature of 80° F. or a little more without apparent injury; but one of 90° to 100° F. was very detrimental.

Further experiments showed that no harm resulted from icing for moderate periods the pupating larvæ and pupæ of *S. tetralunaria* and the pupæ of *E. alniaria*, nor from cooling to about 47° F. the pupating larvæ or pupæ of *E. autumnaria*.

Under the second head some interesting conclusions were arrived at with *E. autumnaria*, *E. alniaria* and *S. tetralunaria*. Eggs from a single pair of the first-named species were divided into batches, and larvæ and pupæ of each batch were brought up under carefully regulated conditions of temperature. The

same general result was obtained as in the 1888 experiments, but the additional fact was established that "it was in the pupal state that the effect was in the main produced. The forced pupæ, whatever the treatment of the larvæ had been, invariably produced pale and comparatively spotless moths; the cooled or iced pupæ, whatever the treatment of the larvæ had been, invariably produced dark and much spotted moths." It was found that a temperature of 63° F., or even higher, was low enough to produce the darker form. The treatment of the larvæ, though of slight effect compared with that of the pupæ, did not seem to be entirely without influence on the perfect insect; *e.g* the specimens that had been forced only as pupæ were darker than those that had been forced all through. Some individual variation was noticed in all the groups. Similar experiments on *E. alniaria* gave results tending in the same direction, but less regular and striking.

The effects on *S. tetralunaria* were far more marked than in 1888. Pupæ of the summer brood were iced for periods successively increased by two weeks up to twenty weeks. These yielded moths becoming generally, but not regularly, more and more like those of the spring emergence, both in colour and pattern, as the period of icing was lengthened. The converse experiment of forcing pupæ of the autumn brood, which would naturally give rise to the spring form of the perfect insect, proved very injurious to the pupæ, the majority of which died even when the temperature was kept at 60° F. only. The moths that emerged were irregular in their time of appearing, and poor in condition. In colouring they were intermediate between the summer and spring forms, those that remained longest in the pupal stage being as a rule the darkest. This autumn spring brood, like the corresponding brood in *V. levana*, is evidently far more resistent in its colouring to temperature conditions than the summer one.

In all three species it was found that the period of pupation was longer for males than for females: most so in *E. alniaria*, least in *S. tetralunaria.*

The broods of *S. tetralunaria* that had fallen off in 1888 showed still further deterioration, both as to health and size, in the spring emergence of 1889. But some eggs of the degenerate race that were sent to Wimbledon produced once more much larger, more numerous and more healthy moths. The cause of this was apparently the change of condition, and especially the substitution of cherry for birch as the food plant.

As a result of this year's experiments, Mr. Merrifield came to the conclusion that the predisposition to assume one or other form in a seasonally dimorphic species can in some cases be completely controlled by external influences applied to egg or larva before the end of its growth; but not, except partially, after larval growth is finished.

Experiments in 1890.—In the course of 1890 the new fact was established that different portions of the pupal period were of different importance for the changes induced by temperature, and that the pattern or outline of the markings could be made to vary independently of the general colouring. It was proved to be possible to obtain by difference of treatment, from the same brood of a seasonally dimorphic species, individuals showing (1) summer markings with summer colouring, (2) summer markings with an approach towards spring colouring, (3) spring markings with summer colouring and (4) spring markings with almost the spring colouring.

A brood of spring larvæ of the light-coloured strain of *S. tetralunaria*, which would naturally have produced moths of the summer form, was forced as a whole; pupating in June. Some of the pupæ were kept at 80° F., these produced well-marked summer forms (Fig. 1). The rest were iced for about twelve weeks, and then either forced or put out of doors. Those that were forced after icing produced moths all of which had the summer colouring, and most of which showed the spring markings (Fig. 3). Some of these which were cooled at 43° F. after the colours of the wings had begun to appear under the forcing process, showed no difference from the rest. Those that were put out of doors after icing (temperature at 8 a.m. averaging about 57° F.) gave moths with the spring markings and a dark colour in some cases almost reaching that of the spring emergence (Fig. 4). Similar experiments on two other broods gave corresponding results, and showed that, in some instances, from two to three days forcing during the last part of the pupal stage might be enough to produce a very marked effect upon the colouring. Another brood, of the third generation, which fed up rapidly and pupated before the middle of August, gave rise at the ordinary temperature of the room (between 65° and 70° F.) to moths of the usual summer markings and colouring, but slightly darker than their forced parents. When twelve of these had emerged, the remaining pupæ were cooled at about 43° F. Those moths that emerged after twenty-six days cooling, while still showing the summer markings, presented an approach to the spring coloration (Fig. 2).

Some striking results were also obtained with *E. autumnaria.* Forcing the pupæ produced, as in 1889, pale and comparatively spotless moths (Fig. 5). When the pupæ were cooled for fourteen days or more before forcing, the ground colour became

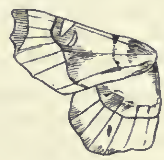


FIG. 1.—*Selenia tetralunaria.* Summer markings and colouring. (Forced.)

FIG. 2.—*Selenia tetralunaria.* Summer markings, spring colouring. (Cooled.)

FIG. 3.—*Selenia tetralunaria.* Spring markings, summer colouring. (Iced, then forced.)

FIG. 4.—*Selenia tetralunaria.* Spring markings and colouring. (Iced.)

All the above were obtained from summer pupæ. Figs. 1, 3 and 4 are from the same parents. The difference should be noted in the shape of the inner area of the wings between Figs. 1 and 2 on the one hand, and Figs. 3 and 4 on the other.

dulled and the spotting blurred. Pupæ cooled for seven to twenty-eight days and then kept at the ordinary temperature of the room gave rise to moths as a rule very much darker than those finally forced; darker even than moths from pupæ that had been cooled for five or six weeks before forcing. The darkest moths of all were obtained from pupæ cooled for five or six weeks and then allowed to develop at the ordinary outdoor temperature, or this followed by cooling (Fig. 6). Even in these, forcing after eight days' exposure out of doors was found sufficient to counteract largely the tendency to darkening.

FIG. 5.—*Ennomos autumnaria.* (Forced.)

FIG. 6.—*Ennomos autumnaria.* (Iced.)

Both the above are from the same parents.

Experiments with *S. tetralunaria* and *E. autumnaria,* on the effect of moisture applied during the pupal stage in combination with various kinds of temperature, gave negative results.

A few trials of the effects of temperature on *Vanessa urticæ*, L. and *Lasiocampa quercus*, L., var. *callunæ*, were made this year, with the general result that cooling the pupa caused enlargement of the blue and dark marks in *V. urticæ*; while forcing the pupa caused increased paleness in *L. callunæ*, making it approach in aspect the ordinary *L. quercus.*

The suggestion was thrown out by Mr. Merrifield that the changes of pattern produced by temperature might assist investigators in tracing the evolution of the wing-markings in modern forms.

Experiments in 1891.—The first result established in 1891 was that the spring emergence of *S. tetralunaria* could be made by forcing during the penultimate pupal period to assume the colouring but not the markings of the summer form. In respect to the colouring it was found to be almost or quite as sensitive to temperature as the summer form, but in respect to markings it was completely resistent. The duration of the pupal period could in no case be shortened to that of the summer form; early and continued exposure of the winter pupa to a temperature of 80° F. or even of 60° F. generally proved fatal.

Experiments on the pupæ of both spring and summer broods of *S. lunaria*, Schiff., and *S. bilunaria*, and on the spring brood of *Falcaria falcataria*, L., gave the same general result of darkening in the cooled specimens and paling in the forced; and previous conclusions with regard to *S. tetralunaria* received confirmation.

In the case of *V. urticæ*, which was this year more completely investigated, it was found that a moderately low temperature generally deepened the colouring slightly, lowered the tone of the yellow patches, and spread the dark portions, especially the borders, enlarging also the marginal blue crescents.

Further experiments were also tried with *Lasiocampa quercus* and its variety *callunæ*. As in the former examples, exposure to a temperature of 80° F. was found to cause lightening, and to a temperature of 47° F. darkening, of the general ground colour. In *L. callunæ* the effect was most pronounced in the males. Some of the forced *callunæ* would, so far as regards colouring, be classed as *L. quercus*. *Arctia caja*, L., was found to be a species unusually intolerant of low temperatures, many pupæ dying when exposed to 50° or 60° F. In those that emerged there was a tendency for the dark spots on the hind-wings to spread and become confluent, and for the black transverse abdominal bars to increase in length and breadth. At 80° to 90° F. the brown of the fore-wings was paler than normal, and the red of the hind-wings took on a yellower shade.

The results obtained in this and former years seemed to Mr. Merrifield to afford evidence that besides the marking and coloration, the size and (less markedly) the shape of the wings might be affected by temperature. In most of the species tried the forced appeared to be smaller than the cooled specimens, and in the three species of *Selenia* a lengthening and increased angularity of the fore-wing seemed to result from a lowered temperature. In *V. urticæ* little difference was observed except in those from pupæ at 47° F., which were generally smaller than the others.

Temperature experiments on *Papilio machaon*, L., *P. podalirius*, L., (spring emergence), *Thais polyxena*, Schiff., *Argynnis paphia*, L., *Cerura vinula*, L., *Agrotis comes*, Hb., and *Attacus cynthia*, Drur. (all *winter* pupæ), gave negative results, as also did a careful trial of the possible effect of darkness and of different coloured light on *S. tetralunaria* and *A. cynthia*.

Experiments in 1892.—The experiments made this year were chiefly on butterflies; the first species taken being *Pieris napi*, L. Pupæ of the summer brood were forced at 90° F. or kept at about 67° F. These yielded perfect insects of the ordinary summer form. Others of the same brood were iced for from three to four months; some were then exposed to an artificial "spring" temperature of 54° F., and the rest were forced at 80° F. Both of these two classes showed most of the characteristics of the usual spring form; *e.g.* on the upper surface greater suffusion and less intensity of dusky colouring; on the under surface faintness of the spots on the fore-wings and strongly marked nervures on all wings, with increased strength of the yellow parts. Those forced after freezing had the nervures more strongly marked than the rest, but in other respects partook less distinctly of the spring colouring. About one-fourth of the pupæ resisted attempts at forcing, and "went over" to the following spring, thus affording another instance of "physiological dimorphism."

A second species taken was *Vanessa atalanta*, L., which gave interesting results. About 100 pupæ were divided into six classes, and treated as under:—

(1) 80° to 90° F., emerging in 6 days.
(2) About 64° F., emerging in 18 or 19 days.
(3) About 56° F. (equable); emerging in about 34 days.
(4) 51° to 64° F. out of doors, averaging about 54°; emerging in 44 days.
(5) 45° to 58° F., averaging about 51°; emerging in about 40 to 50 days.
(6) 45° F. for from 32 to 47 days, then to various temperatures ranging from 90° F. (emerging in 6 days more) down to a mean of about 55° (emerging in from 19 to 34 days more).

Classes 2, 3 and 4 did not greatly differ among themselves or from the normal; their coloration, however, seemed on the whole to increase in intensity with the lowering of the temperature. In Class 1 the black ground-colour was slightly suffused with golden brown, the scarlet band was broadened, and its intensity of colour somewhat diminished. A new scarlet spot appeared on the under surface of the fore-wing (Fig. 9). In Class 5 the pale costal patch on the under surface of the hind-wing became more pronounced, and showed an increased tendency to spread along the costa. A light ochreous cloud about the middle of the hind margin of the same wing-surface, visible in normal specimens, became more strongly marked. In Class 6 the scarlet band was tinged with carmine, narrowed in area, and broken up by transverse bars of black. There was a tendency in the fore-wing to the diffusion of white and lavender scales over the black ground-colour, and round the edges of the

FIG. 7.—*Chrysophanus phlœas.* (Diagrammatic.) Forced; showing large size of black spots on fore-wing, and diminished breadth of copper border on hind-wing.

FIG. 8.—*Chrysophanus phlœas.* (Diagrammatic.) Iced; showing diminished size of black markings, and increased breadth of copper border. The latter has lost its external serrations, and shows prolongations passing inwards along the nervures.

FIG. 9.—*Vanessa atalanta*, under side. (Diagrammatic.) Forced; shows appearance of new red spot (*a*) between scarlet band (*b*) and inner border of fore-wing.

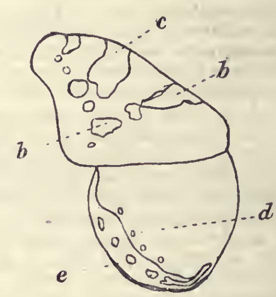


FIG. 10.—*Vanessa atalanta*, upper side. (Diagrammatic.) Cooled; shows scarlet band (*b*) broken up, enlargement of white costal mark (*c*), new row of minute blue spots (*d*). The submarginal spots of the hind-wing (*e*) are centred with lavender.

white spots. The submarginal black spots of the hind-wing were often centred with lavender, occasionally a row of minute blue spots appeared in the margin of the dark portion of the hind-wing, and another on the extreme border of the wing itself (Fig. 10). On the under side there was more diffusion and blurring of markings, with an increased tendency towards the multiplication and spreading of pale areas.

Chrysophanus phlœas, L., a species which had already been worked at by Weismann, was also made the subject of a series of temperature experiments. Well-marked differences were found to exist between the extreme forms produced under conditions of heat or of cold. The former caused enlarged size and diminished intensity of the black spots, a narrowing of the coppery band on the hind-wing, and a dusky suffusion of the fore-wings, especially towards the bases (Fig. 7). Under the latter, the black spots are much reduced in size, the coppery parts are lighter, and the coppery band on the hind-wing broadens, loses its posterior serrations, and often shows prolongations along the nervures towards the base (Fig. 8). These effects are

noteworthy inasmuch as they differ considerably from the results of heating and cooling in other species. Their peculiar relation to the temperature conditions is also remarkable; thus, summer pupæ kept at 33° F. for ten weeks, if afterwards allowed to remain at 55° F., gave the cold form in its extreme development; but if forced at 90°, gave the heat form almost as perfectly as those kept at 80° to 90° all through. Another curious point is that whereas a temperature of 47° F. was very injurious to the pupæ, they bore icing at 33° F. for ten weeks without damage.

Leucophthalmia punctaria, L., which was also tried during this year, gave results in some respects like the above. Thus, though forcing at 90° F. or icing at 33° were borne without injury, exposure to 45° proved harmful. Again, as in *C. phlæas*, "a temperature of 33° F. seemed to suspend the physiological changes without much other effect," for the pupæ exposed to this temperature for over three months, and afterwards forced, gave the heat form in almost as complete a state of development as those forced from the beginning. Summer pupæ were used for the experiment, and the general effect of cooling was to cause "gradual disappearance of the submarginal blotches, increase of dark sprinkling, and intensification of the central line as the temperature was lowered."

To Mr. Merrifield's account of his experiments during this year a short paper was appended by the present writer, giving reasons for considering certain of the modifications produced in *V. atalanta* by both heat and cold to be ancestral in character.[1] Some of the new features produced by heat were considered to show an approach towards *V. callirrhoe*, Hb., and some of those produced by cold appeared to indicate reversion to a still older form of *Vanessa*.

Experiments in 1893.—A number of winter pupæ of *Picris napi*, L., were divided into groups, some being forced in February and March, others left to emerge out of doors, which they did in late April and early May. The two divisions showed the same kind of difference, though in less degree, as was apparent in the summer brood of 1892 between those forced throughout and those cooled for the greater portion of their pupal period.

Experiments on both summer and winter pupæ of *Pararge egeria*, L., showed that the general effect of forcing was to lighten the ground colour and cause the pale spots to become smaller and less well defined. In no case was any approach shown to the bright ochreous colouring of the South European form.

In *Hydriomena silaceata*, Hb., cooling the summer pupæ caused an approach towards the usual colouring of the spring emergence; while forcing, besides producing a more uniform appearance, generally diminished the size of the perfect insect.

A trial was also made of the summer pupæ of *Araschnia levana*. The results were in general accordance with those previously obtained by Weismann; the effect of a raised temperature being to produce the dark *prorsa* form, and that of low temperatures (from 48° F. downwards) being to cause the appearance of the pure *levana* type, a few of those only exposed to moderately low temperatures showing slight traces of the intermediate *porima* colouring.

Interesting experiments were made on four species of *Vanessa* —*V. polychloros*, L., *V. atalanta*, L., *V. c-album*, L., and *V. io*, L. Pupæ of *V. antiopa*, L., gave negative results, probably in consequence of being already too far advanced when their treatment began.

In *V. polychloros*, high temperatures caused a general lightening of the ground colour and the appearance of yellowish clouds and streaks; the ordinary black spots were sharply defined. It was found that yellowish marks made their appearance to a greater or less extent when a temperature of 80° or upwards was employed, even if the pupæ had previously been cooled or iced for some weeks. When exposed to low temperatures, the pupæ produced perfect insects with a deeper and duller ground colour and a spreading of the dark marks, especially of the submarginal band. The enlargement of this band was always observed in cooled or iced specimens, whether subsequently forced or not. The whole ground-area was generally dusted with black scales, which tended to form new spots, especially in a row parallel to the outer margin in both fore- and hind-wing (Fig. 13).

Fresh experiments on *V. atalanta* confirmed the previous year's results and added new ones. Forcing temperatures up to 100° F. were employed, with the result of killing many of the pupæ. Those specimens that emerged showed a scarlet cloudy patch in that portion of the fore-wing which corresponds to the centre of the ocellus in *V. io*; and some of them showed another new scarlet spot on the under side of the fore-wing, in addition to the new spot observed in 1892. One of the apical white spots tended to be loosely ringed with scarlet in the forced, and with white in the cooled specimens. The latter were generally undersized.

In *V. c-album* it was found that both the first and second brood, but especially the first, became darker if exposed to a moderately low temperature.

Forced specimens of *V. io* showed a tendency to the development of dark spots near the apices of the nervular interspaces. Cooled and iced specimens showed a tendency, increasing as the temperature was lowered, for the dark costal "claw-mark" of the fore-wing to lose its regular curve and become angulated, for the apical pale spots to separate themselves more distinctly from the remains of the dark submarginal band, and for the bluish constituents of the ocellus in the hind-wing to divide themselves into two parallel series, a marginal and a submarginal. The resolution of the ocellus in the fore-wing was in one specimen very complete (Fig. 11).

A paper by the present writer drew attention to the further reversionary features disclosed by the temperature modifications

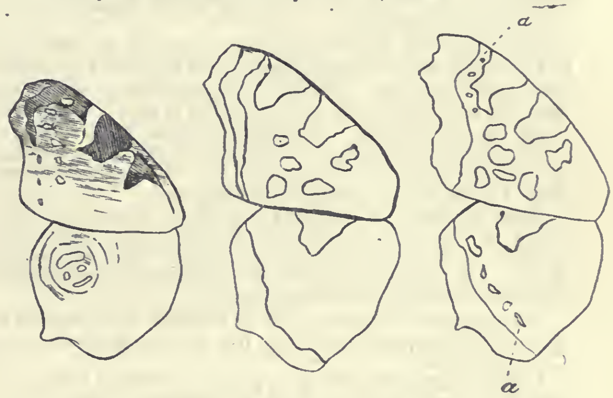


FIG. 11.—*Vanessa io*. (Diagrammatic.) Iced; showing resolution of ocellus.

FIG. 12.—*Vanessa polychloros*. (Diagrammatic.) Forced; shows size of black marks somewhat reduced. The yellow markings are not represented.

FIG. 13.—*Vanessa polychloros*. (Diagrammatic.) Iced shows tendency to formation of new submarginal row of black spots (*a*) in fore- and hind-wing.

above described, and commented on the significance of these phenomena with reference to the centripetal and centrifugal theories of heredity.

Experiments in 1894.—Pupæ of *Limenitis sibylla*, L., were found to be intolerant of heat. Those that survived a temperature of 85° to 90° F. gave rise to perfect insects with a slight increase of reddish scales near the apex of the fore-wings and the anal angle of the hind-wings. The orange-brown of the under surface was enlarged in area and paler in colouring. Exposure to a temperature of 48° F. for from three to five weeks caused a sprinkling of the white band with black scales, and on the under surface an increase in area and intensity of some of the darker parts with a tendency to suffusion and spreading of the white.

As a result of further experiments on *Vanessa c-album*, it was found that in certain of those exposed to low temperatures, which were not well borne by this species, there was an increase in the distinctness of the submarginal series of dark spots. Some of these were pupilled with bluish or lavender scales, as in the Chinese *V. c-aureum*, L., which appears to present an early form of the *Vanessa* pattern.

A few experiments were also made on *V. cardui*, L., giving results in accordance with those previously obtained by Standfuss in Zürich.

Experiments in 1895.—Both high and low temperatures (98° F. and 33° F.) were found to be well borne by pupæ of *Gonepteryx rhamni*, L. Little change was produced in the

[1] Weismann has expressed his general concurrence with these and subsequent conclusions of the present writer as to reversion (*Neue Versuche*, Jena, 1895, pp. 51, 72).

appearance of the imago, but the general effect of the low temperature was to reduce or abolish the orange discoidal spot on the fore-wing of both sexes, while under the high temperature the pale hue of the female appeared to assume a yellower tinge. In one instance this effect was well marked.

In *Vanessa atalanta* some further changes were observed as the result of high temperatures; the most remarkable of which were the appearance of a scarlet patch on the fore-wing between the red cross-band and the costa, and a long streak of grey-blue scales near the inner margin of the same wing. The most efficacious way of producing these modifications in this and other species of *Vanessa* appeared to be the use of a temperature of 95° F. to 102° F. for 12-14 hours at an early stage, afterwards gradually lowered, but still kept up to 85° F. or more till near emergence.

Some cooled specimens of *V. urticæ* bore great resemblance to the northern variety *polaris*. Heated specimens were like the southern form *ichnusa* in the shade and extent of the red ground colour, and also in the tendency towards disappearance of the isolated dark spots on the fore-wing. All three spots, however, were affected in these specimens, whereas in *ichnusa* the spot nearest the hind margin retains the normal appearance. Other changes were observed in the outer border, and in the shape of the fore-wing, the angulation being diminished.

Pupæ of *V. antiopa* at a low temperature gave similar results to those obtained with this species by Dr. Standfuss, but they were much less marked.

Experiments in 1896.—Pupæ of *P. daplidice*, L., from eggs laid in March, kept at a temperature of 70° F. to 80° F., gave the ordinary summer form. Some of the same batch, kept in the open air after five or six weeks' cooling at 52° F., emerged as the spring form *bellidice*. In *Melitæa didyma*, Esp., cooling at 51° F. was found to produce an extension of the black markings on the under side of the hind-wings. Of two specimens forced at 94° F., one was of an abnormally fiery tint.

Some specimens of *Saturnia pavonia*, L., from North Italy, forced in late winter and early spring, were much paler, ruddier and more uniformly coloured than those kept out of doors. This species is therefore not so resistent to temperature-conditions as many other winter pupæ.

Vanessa urticæ, var. *polaris*, from Lapland, was found to be sensitive to temperature, though less so than specimens from Central Europe.

Further experiments during the present year (1897) have shown that the tawny ground colour in *Argynnis paphia*, L., is brightened, and the size of the dark markings reduced by warmth, while the contrary effect follows exposure to cold. Also in *Aporia cratægi*, L., a low temperature causes much thickening and spreading of the black lines which mark the course of the nervures.

This ends the series of experiments so far undertaken and carried out by Mr. Merrifield. It is to be hoped that he will be able to continue and extend researches so interesting in themselves and so valuable to science. The present paper is concerned with facts only, not with their interpretation; but it must be obvious to any one who considers the remarkable results here briefly recorded, that they constitute an important contribution towards the better understanding of many disputed questions.

It may be well in conclusion to give Mr. Merrifield's own enumeration of the kinds of change observed. "The changes produced by temperature," he says, "are mainly of three kinds, viz. (1) general change, often striking, in the colouring, without material alteration in the pattern or form of the markings, but often with much enhancement or diminution in their intensity; (2) change caused by the substitution of scales of a different colour, either singly and generally distributed so as to be scattered, or so grouped as to cause a material change in pattern; (3) change in general appearance caused by imperfection in the development of scales or of their pigment. No. 1 seems a direct effect of temperature, not affecting vigorous development. Under No. 2 are to be ranged the most radical changes in pattern, as in the extreme case of *Araschnia levana-prorsa*, which have been explained on the theory of reversion to an earlier form. In No. 3 the wings are often somewhat reduced in size; the scales are scanty, irregularly placed, and often misshapen and deficient in pigment, the membrane of the wing showing between them. The three are more or less combined in many cases."

The figures which illustrate this paper were drawn from the plates which accompany Mr. Merrifield's papers in the Entomological Society of London's *Transactions*. F. A. DIXEY.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Vice-Chancellor announces that he has opened a University Benefaction Fund, to which he has placed during the present term donations for various academic purposes amounting to nearly 3500*l.* This sum includes a gift of 1000*l.* from Dr. Peckover, Lord-Lieutenant of Cambridgeshire, and a grant of 1050*l.* from the Mercers' Company for the rebuilding of the medical schools. The family of the late Sir George M. Humphry, Professor of Surgery, have contributed 600*l.* towards the latter object, by way of a memorial gift; and Mr. H. Westwood Hoffman, 100*l.*

The Rede Lecturer for the ensuing year is Sir Henry Irving. Prof. Ewing, F.R.S., has been appointed Chairman of Examiners for the Mechanical Sciences Tripos. Mr. A. F. Stabb has been appointed University Lecturer in Midwifery.

The examinations in Sanitary Science will begin respectively on April 19 and April 26, 1898, the incidence of Easter having rendered the advertised dates inconvenient.

A scheme of theoretical and practical training has been organised for members of the University who are intending to become masters in public schools. The scheme is under the direction of the Teachers' Training Syndicate, and will be carried out in connection with the existing Day Training College. Certificates of efficiency will be granted to candidates who have pursued the prescribed course and passed the examinations of the Syndicate.

THE Council of the Institution of Civil Engineers have awarded a Salomons scholarship of 50*l.* to Mr. Edward Ernest Tasker, a student of the Technical College, Finsbury.

THE University of Upsala has received from Mr. Franz Kempe the sum of 150,000 knonor (about 8333*l.*) for an associate professorship of plant biology. Dr. Lundström has been nominated to occupy the chair.

SINCE the beginning of the academical half-year (states the *Lancet*) all students attending the chemical and physical laboratories of the University of Heidelberg have been insured against accidents happening in the course of the lectures, of the laboratory work, and of scientific excursions. The insurance premium is paid by the treasury of the University, which has also made a new regulation in connection with the subject requiring the students to pay a small sum in addition to the class fees.

A Fellowship to be called the Geoffrey Fellowship, of the value of 100*l.* a year for three years, has been presented to Newnham College, Cambridge, and will be awarded in June 1898. The Geoffrey Fellow will be required to reside at Newnham College, and to pursue independent study in some department of learning, letters or science. Candidates must be women who have obtained honours in a Cambridge Tripos Examination or in the Oxford Final Schools. They should send in their names to Mrs. Verrall, President of the Associates of Newnham College, before May 1, 1898. Each application should be accompanied by a statement of qualifications, a scheme of the work which the candidate proposes to carry out, and, if possible, a dissertation or other evidence of work done. Further information respecting conditions of tenure, &c., may be obtained from Mrs. Verrall, Newnham College, Cambridge.

SPEAKING at Northampton a few days ago, Lord Spencer urged that great efforts should be made to improve secondary education in England. Much had been done for education in the Victorian age, but it was absolutely necessary to fill the gaps existing between primary education and University education. He trusted that the measure which the Government would introduce would be satisfactory to all educationists, and he knew if it was it would have the support of even the opponents of the Government. One of the great difficulties in the way of carrying out technical education was the want of good secondary education. No more useful measure had been passed during the reign of the Queen than that giving county councils and borough councils grants for technical education, for it had stimulated a desire for secondary education and technical education. What was now wanted was a measure which would put technical education on something of the same basis, though not perhaps under the same supervision, as primary education. More aid was wanted from public funds and from rates. When they had that they would have attained something of great benefit to the

people of the country. Technical education was necessary. He was not one of those who could see for a moment that the prosperity of England was on the wane. But if England meant to keep her position in the commercial world she must not be behind with regard to the most important thing which had arisen in modern days connected with commerce—namely, the necessity of giving technical instruction to those who had to work in England's commercial market.

SCIENTIFIC SERIALS.

American Journal of Science, December.—A microsclerometer, for determining the hardness of minerals, by T. A. Jaggar. This instrument depends upon the energy required to make a boring of a certain diameter and depth under a given weight and by means of a diamond point of a cleavage tetrahedron of perfect shape. The hardness is measured by the number of turns required to make the boring, or by the depth reached after a certain number of revolutions. The depth is measured by a microscope attached to the boring point, by bringing successive divisions of a slanting micrometer scale into focus. The values found for the hardness of Mohs's scale-minerals show even greater gaps than those obtained by Pfaff and Rosival. Taking corundum as 1000, topaz is 152, quartz 40, orthoclase 25, apatite 1·23, fluorite 0·75, calcite 0·26, and gypsum 0·04.—On the sapphires from Montana, by G. F. Kunz. Sapphires were first found in transported gravels along the bars of the Upper Missouri, then in the earthy products of decomposed dikes, and lastly further down in the unaltered igneous rock itself. Much beautiful material has already been obtained, but little of high value.—On the corundum-bearing rock from Yogo Gulch, Montana, by L. V. Pirsson. The dikes of igneous rock containing sapphire and corundum are of a dark grey, basic appearance, and have an uneven fracture. In thin sections it appears as a dark lamprophyre, consisting mainly of biotite and pyroxene. There is a little iron ore present, but much less than is usually seen in rocks of this class.—Electrical measurements by alternating currents, by Henry A. Rowland. Gives some twenty-four methods of measuring inductances, capacities and resistances by means of alternating currents. Some of these depend upon a new principle in the shape of an adjustment of two currents to a phase difference of 90°. This is done by passing one current through the fixed, and the other through the suspended coil of an electrodynamometer. The fixed coil may then be made to carry a heavy current, and the sensitiveness of the apparatus is greatly increased. Inductances can be compared to within 1 in 10,000, but care must be taken not to twist the leads, as their electrostatic action is then very great. The question of standard inductances is thus practically solved.

THE latest issue of the *Izvestia* of the Russian Geographical Society is of exceptional interest. It contains, first, a brief sketch, by P. K. Kozloff, of the Roborovsky's Tibet expedition, in which the author dwells especially upon his own "excursions"—that is, the journeys which he made separately from the main body of the expedition, and gives very valuable data relative to the nature, and especially the animal world, of the visited regions. The reports about the journey in the Sy-chuan province, and to the Southern Kuku-nor ridge are especially interesting.—The geologist, E. E. Anert, contributes a very valuable sketch of his journeys in Manchuria. He started from the Suifun river, near Vladivostok, and went first to Ninguta, and then to Ghirin, the capital of Manchuria, where he took a boat and went down the Sungari till its junction with the Amur. The great Manchurian river, up to Ghirin, has been described already in 1864, by the expedition of Colonel Chernyaeff, who had with him the astronomer Usoltseff and P. Kropotkin; but the papers of these two explorers, which were printed in the *Memoirs* of the Siberian Geographical Society, were destroyed, as well as the original maps, during the Irkutsk conflagration, and remained almost quite unknown to geographers.—A third paper, of great interest, is by V. I. Lipsky, who was the leader of the Hissar expedition of 1896. Notwithstanding great difficulties, due to heavy snowfalls in winter, which were followed by heavy rains in spring, Lipsky explored the Hissar ridge from the south. The heights of the passes are from 12,000 to 14,000 feet. Ten new glaciers were discovered; they all lie above the 10,000 feet level, and are all surrounded by large moraines testifying to their previous larger extension.—The fourth paper is by Th. K. Drizhenko, who was at the head of a hydrographic expedition for the exploration of Lake Baikal in 1896. The paper is accompanied by a map of the lake showing the positions of the 100, 400 and 700 fathoms depth-lines, and another map showing the distribution of surface temperature during the month of August. The work of the expedition was continued this summer as well.—In the same issue G. V. Levitsky discusses the advisability of having a few seismic observatories in Siberia and Central Asia, each provided with a horizontal pendulum.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 9.—"On the Refractivities of Air, Oxygen, Nitrogen, Argon, Hydrogen, and Helium." By Prof. William Ramsay, LL.D., F.R.S., and Morris W. Travers, B.Sc.

In the course of an investigation on the nature of helium, many measurements of the refractivities of different samples were made with a view to determining their composition.

Since, on account of the great difference between the refractivities of air and helium, it was found inconvenient to compare the two gases directly, the helium was compared with hydrogen, and the refractivity of the hydrogen was afterwards determined with regard to air. As a check the hydrogen was subsequently compared with oxygen, and nitrogen free from argon, these gases were also measured against one another, and against air. At a later stage in the investigation the refractivities of argon and carbon dioxide were also determined.

The measurements were made by the interference method described by Lord Rayleigh (*Proc. Roy. Soc.*, 59, 198-208).

Special attention was paid to the purity of the gases examined, and a full description of the methods of preparation is given in the paper. It is possible that the discrepancies between the results obtained by various observers may be due to the presence of impurities in the gases which they employed.

The mean values obtained for the refractivities of the gases examined are tabulated below.

Refractivities of Gases, Air equal to Unity.

	Directly compared.	Through Oxygen.	Nitrogen.	Hydrogen.	Argon.
Hydrogen ...	0·4733	0·4737	0·4727	—	—
Oxygen ...	0·9243	—	0·9247	0·9237	0·9261
Nitrogen ...	1·0163	1·0155	—	1·0170	1·0191
Argon	0·9596	0·9577	0·9572	—	—
Carbon dioxide	—	1·5316	—	—	—

Calculated from the determinations given above, assuming Dale and Gladstone's formula for mixtures of gases, the refractivity of air becomes 99·647 instead of 100.

Turning to the determinations of other investigators, it was found that since Dulong, in 1826, no single experimenter had made measurements of both oxygen and atmospheric nitrogen. Mascart determined the refractivity of nitrogen, and found it to be 1·0178, a value which closely agrees with the figure given above.

Lorenz determined the value for oxygen, 0·9347, but there is reason to doubt the purity of the gas which he employed. The refractivity of air calculated from the data of Mascart and Lorenz becomes 100·15.

Since the value obtained for the refractivity of air, calculated from the values obtained for oxygen, nitrogen and argon, differs from 100 by an amount far exceeding the limit of experimental error, we were driven to the conclusion that the refractivity of air is somewhat less than the refractivities of its constituents, taken in the proportion in which they occur.

It appeared advisable to try other mixtures; and a mixture of hydrogen and helium was first selected, because these are both very "perfect" gases, inasmuch as their critical points lie very low. It was to be expected that if a difference between calculated and found values should exist, it should be of the inverse character to that of a mixture of oxygen and nitrogen, for they are two somewhat "imperfect" gases. The result has borne out this idea.

A mixture was made of 20·60 c.c. of hydrogen and of 20·12 c.c. of helium free from argon, and of the density 1·960; and with the refractivity of the mixture those of hydrogen and

helium were compared. Taking the refractivity of the mixture as unity, the following ratios were found:—

Hydrogen/mixture ...	1·5977	Mean ...	1·5967
	1·5957		
Helium/mixture ...	0·4513	,, ...	0·4495
	0·4478		

The calculated values are—

$$\frac{(\cdot 04495 \times 20\cdot 12)}{40\cdot 72} = 22\cdot 21$$

$$\frac{(1\cdot 5967 \times 20\cdot 60)}{40\cdot 72} = \frac{80\cdot 87}{102\cdot 99}.$$

Here the calculated value of the refractivity of the mixture is 3 per cent. higher than the found value, while with air the calculated value is 0·35 per cent. too low.

A third experiment was made, in which the "artificial air" was a mixture of 19·13 c.c. of carbon dioxide with 19·29 c.c. of oxygen, both gases supposed to be at 0° and 760 mm. Again, taking the refractivity of the mixture as unity we found the following ratios:—

Carbon dioxide/mixture	1·2450
Oxygen/mixture	0·7525

The calculated values are:—

$$\frac{(1\cdot 2450 \times 19\cdot 13)}{38\cdot 42} = 61\cdot 99.$$

$$\frac{(0\cdot 7525 \times 19\cdot 29)}{38\cdot 42} = \frac{37\cdot 78}{99\cdot 77}$$

Here, as with air, the total refractivity found is less than that calculated. It is true the difference is not great, but we are persuaded that it is real, for it considerably exceeds the error of our several determinations.

The case is not bettered if Lorentz and Lorenz's formula be substituted for Gladstone and Dale's. Using their formula, $n^2 - 1/n^2 + 2$, the calculated result is 99·72 per cent. of that found for air.

The coefficient of compressibility of hydrogen is too small, while that of other gases, such as oxygen and nitrogen, is too great. The effect of mixing equal volumes of hydrogen and helium, each of which has too large a coefficient of elasticity, is to cause each to occupy twice the volume that they previously occupied, and to halve approximately the pressure for each. The pressure is, therefore, lower than it would be for an absolutely ideal gas, for each gas, hydrogen and helium. The sum of these pressures will accordingly be too low, or transposing, the sum of the volumes will be too great. The opposite argument holds for air.

Now, in considering volumes, we deal not merely with the co-volume, *i.e.* the space occupied by the molecules, but also with the interstitial space inhabited by the molecules. But the refractive power, if Clausius's deduction from the formula of Lorenz and Lorentz is correct, is a function of the dielectric constant, and hence of the co-volumes of the gases. And here the discrepancy is more easily detected than by any determination of density. It must, therefore, be concluded that gases are not, as postulated by Dalton, indifferent to one another's presence, but that they modify one another's properties in the same manner as do liquids, though to a different extent. This mutual action at high pressures and small volumes modifies even the volume relations, as recently shown by Dr. Kuenen. And it must persist at low pressures and large volumes, though it may not always be possible to make measurements of pressure and volume accurate enough to lead to its detection. The refractivity, however, seems to be a means delicate enough to be used for this purpose.

"The Electric Conductivity of Nitric Acid." By V. H. Veley, F.R.S., and J. J. Manley, Daubeny Curator of the Magdalen College Laboratory, Oxford.

In this paper an account is given of determinations of the electric conductivity of nitric acid of percentage strengths from 1·3 to 99·97, purified from nitrous acid, sulphuric acid and the halogen acids. Special forms of apparatus, and special methods of measurements were adopted to overcome the difficulties of polarisation of the concentrated acid.

The chemical and certain physical properties of the practically anhydrous acid were studied; this acid has no action on various metals such as copper, silver, cadmium, mercury, magnesium, iron and tin, nor on calcium carbonate either at ordinary temperatures or at the boiling point. Sulphur and iron pyrites dissolve quickly and completely in the gently-warmed acid. The values are given for the corrected density at 4/4, 14·2/4 and 24·2/4 of the 99·97 acid, as also for thirty-two samples of acid of $K_0 \times 10^8$, $K_{15} \times 10^8$, $K_{30} \times 10^8$, viz. conductivity in mercury units, and for $\alpha 10^4$, and $\beta 10^6$, the temperature coefficients in the equation $R_t = R_0(1 - \alpha t + \beta t^2)$. It is shown that whereas nitric acid behaves as other electrolytes in possessing a positive temperature coefficient of conductivity for percentage strengths from 1·3 to 96·12, yet from this point upwards it behaves as a metallic conductor. The results of the experiments point to the existence of hydrates of nitric acid containing $10H_2O$, $3H_2O$, $2H_2O$ and H_2O, with one molecular proportion of HNO_3 and of $1H_2O$ with $2HNO_3$, or $H_4N_2O_7$, the analogue of pyrophosphoric acid. Evidence is thus added to that previously accumulated of definite combinations of nitric acid with water.

Chemical Society, December 2.—Prof. Dewar, President, in the chair.—The following papers were read:—The representation of the isomeric benzene hexachlorides by Collie's space-formula, by F. E. Matthews. The author shows that Collie's space-formula for benzene satisfactorily explains the existence of two benzene hexachlorides; amongst other facts explained are the different stability of the isomerides and the formation of only two.—Compounds of piperidine with phenols, by O. Rosenheim and P. Schidrowitz. A number of addition products of piperidine and phenols or their derivatives of a salt-like nature have been prepared in which the phenol acts as an acid; they are crystalline, and are decomposed by strong alkalis or acids.

Royal Meteorological Society, December 15.—Mr. E. Mawley, President, in the chair.—Mr. W. Marriott read a paper on the rainfall of Seathwaite, Cumberland. This place has long been noted for its heavy rainfall, being in fact one of the wettest spots in the British Isles—the average yearly amount is 137 inches. The spring months of April, May and June are the driest, so they not only have the least rainfall, but also the least number of rainy days. August, the month when the Lake District is thronged with visitors, has the greatest number of rainy days. The heavy nature of the rainfall may be gathered from the fact that 21 per cent. of the falls are above 1 inch, 2 per cent. being above 3 inches. The greatest fall in one day was 8·03 inches on November 12. The author has investigated the atmospheric conditions under which the heavy rainfalls occurred at Seathwaite, and he finds that these heavy falls are due to the direction and force of the wind. When the wind is blowing strongly from the south-east or south-west, it will be concentrated in the valleys on the windward of Scafell, and rush up them with considerable force, the air current consequently being projected to a considerable altitude beyond Scafell. Owing to the reduction of temperature with elevation, the air parts with a great deal of its moisture, which falls as rain. With such a process going on continuously for a whole day, the heavy rainfall at Seathwaite is fully accounted for.—Mr. R. C. Mossman also read a paper on the daily values of non-instrumental meteorological phenomena in London from 1763 to 1896. The phenomena discussed were thunderstorms, lightning without thunder, fog, snow, hail and gales.

Cambridge.

Philosophical Society, December 6.—Mr. F. Darwin, President, in the chair.—Features of interest in the fauna of the Sandwich Islands (with exhibitions), by Mr. R. C. L. Perkins. Mr. Perkins exhibited and read some notes on some of the more interesting insects from the Hawaiian Islands. Several species of endemic dragon-flies (*Agrioninæ*) were shown, some of which passed their earlier stages in water, in the usual manner, while others in the nymph state lived amongst the leaves of a liliaceous plant, the diversity in habit having probably been brought about by the extreme poverty of the freshwater fauna, the terrestrial species being much more favourably situated in regard to a constant supply of food. A series of examples of three or four allied species of Longicorn beetles of the genus *Plagithmysus* were remarkable for their extreme variability in colour, in spite of their limited range. The varieties of each species fell into two or three groups, which were hardly, if at all, connected by intermediate forms. The differences between the extreme forms of a species were in some cases more striking than the differences between the species themselves. The habits of these beetles, and the several distinct

sets of stridulating organs with which they are furnished, were also referred to. A collection of wasps from the islands of Molokai and Kauai were exhibited, to show the great difference in superficial appearance between those inhabiting the latter island, and those from the rest of the group. No protective significance could be attributed to the uniform and conspicuous markings of the Kauai species.—Remarks on a journey to investigate the habits and development of *Lepidosiren paradoxa*, by Mr. J. Graham Kerr. The author gave a short account of an expedition which he had made to the interior of the Gran Chaco of Paraguay for the purpose of investigating the habits and development of *Lepidosiren paradoxa*. He was aided by a grant from the Balfour Fund, and was accompanied by Mr. J. S. Budgett of Trinity College. Lepidosiren occurs in considerable quantity in the swamps towards the centre of the Gran Chaco boreal. It is sluggish in habits, wriggling slowly about among the thick vegetation of the swamp. At short but very irregular intervals it visits the surface and takes a breath of air. Its food consists mainly of large Ampullarias and masses of confervoid algæ. The young are to a greater extent vegetable feeders than are the adults. Lepidosiren makes a burrow in the ground at the bottom of the swamp, and lines it with soft grass. In this the eggs are laid. The papillæ on the hind limb of the male grow out into long filaments during the breeding season, and during life these are blood-red in colour. They appear to be ornamental structures. The eggs are very large—about 7 mm. in diameter. Cœlomic eggs have a thick gelatinous coat: in fertilised and developing eggs this becomes thin and horny. Segmentation is during its later stages holoblastic and unequal. Gastrulation takes place in a manner which recalls that of *Urodele amphibia*, and of Cyclostomes. Eventually a tadpole larva is hatched out. This develops large external gills and a very large sucker of the Amphibian type. The external gills and sucker disappear about six weeks after hatching. At the same time the colour of the young Lepidosiren becomes much darker, and they become much more lively in their habits. For the first ten to twelve weeks of its free existence the young Lepidosiren does not eat, but lives on the yolk in the walls of its gut. A remarkable habit of Lepidosiren was mentioned, in that their normally very dark colour becomes during the night nearly white. The black chromatophores shrink up during the hours of darkness, large yellow chromatophores which are also present remaining expanded. During the dry season the Lepidosiren retreats into the mud, in which it remains breathing by means of an air-hole until the waters return and set it free.

EDINBURGH.

Royal Society, December 6.—The following are the president and vice-presidents for the coming session:—Lord Kelvin; Lord McLaren, Rev. Prof. Flint, Prof. McKendrick, Prof. Chrystal, Sir Arthur Mitchell, and Sir William Turner. Papers were read as follows:—On the food, fuel, and air of the world, by Lord Kelvin.—Chapters on the mineralogy of Scotland, chapter viii., Silicates, by the late Prof. Heddle.—Note on the disturbance of the magnetic and meteorological instruments at the Colaba Observatory during the earthquake of June 12, 1897, by N. A. Moos.—On a problem of Sylvester's in elimination, by Prof. E. J. Nanson.—On the velocity of graded actions, by Prof. Walker.—Preliminary note on a characteristic of certain chemical reactions, by Prof. Gibson.—On the directions which are most altered by a homogeneous strain, by Prof. Tait.

Mathematical Society, December 10.—Mr. J. B. Clark, President, in the chair.—The following papers were read:—Some questions in arithmetic, by Prof. Steggall.—Methods of solution of the equations of elasticity, by Mr. John Dougall.—Trigonometrical notes, by Prof. John Jack.—Note on a transformation of the equations of hydrodynamics, by Mr. Carslaw.

PARIS.

Academy of Sciences, December 13.—M. A. Chatin in the chair.—The election of M. Ditte, as a Member in the Section of Chemistry, was confirmed by the President of the Republic.—On the work carried out in 1897 at the observatory at Mt. Blanc, by M. J. Janssen. The chief work done was on the value of the solar constant, although the observations were much interfered with by the unfavourable weather.—On the periods of double integrals, by M. H. Poincaré.—Signification of the number and symmetry of the fibro-vascular bundles of the petiole in the measurement of the perfection of plants, by M. Ad. Chatin.—On the first modifications of nerves in simple wounds of the cornea, by M. L. Ranvier. The nerve fibres of the cornea, which are divided by section, grow with an unexpected rapidity and activity, if they are in continuity with their origin cells.—Remarks, by M. Lœwy, on presentation of the annual publications of the Bureau des Longitudes.—On a new method for determining the vertical, by MM. J. Perchot and W. Ebert. The method of Deichmüller, floating a mirror in a bath of mercury, can be modified to give good results which are free from the prejudicial effects of capillary phenomena The results are as accurate as with the plain mercury bath, and good measurements can be obtained in Paris, where the amount of vibration renders the use of the plain bath very troublesome.—On the problem of Ribaucour, by M. C. Guichard.—On an analytical form of the integrals of linear partial differential equations of two independent variables, by M. J. Le Roux.—On the resolution of certain differential systems, by M. Riquier.—On a double generalisation of the equations of Lie, by M. E. Vessiot.—On the positions of unstable equilibrium, by M. P. Painlevé.—On the displacement of a plane of which all the points describe spherical lines, by M. Raoul Bricard.—The problem of the distribution of electricity and the problem of C. Neumann, by M. W. Stekloff.—New method of attacking platinum. Preparation of the bromoplatinates of ammonium and potassium, by M. Georges Méker. Platinum is attacked by a fused mixture of ammonium sulphate and bromide, although it resists the action of either salt taken separately. Ammonium bromoplatinate is readily isolated in a pure state from the fused mass.—On phosphorous oxide, by M. A. Besson. By warming together H_3PO_3 with an excess of PCl_3 on the water bath, and washing the product with water, a reddish solid is left, which on analysis gives exact figures for the oxide P_2O.—Properties of sodium carbide, by M. Camille Matignon. The carbide forms a white powder, not explosive by shock or by friction. On slight heating, it burns in air to sodium carbonate. In chemical activity, sodium acetylide far exceeds the corresponding calcium compound, nearly all the reactions being so violent that carbon is set free, and the sodium acting as in the free state.—On a new series of cyclic ketones, by M. A. Béhal. The fractional distillation of the heavy oil from wood tar, followed by conversion the benzoyl-oximes, has furnished two new ketones.—On the neutralisation of glycerophosphoric acid by alkalis, in presence of helianthine and phenolphthaleïn, by MM. H. Imbert and A. Astruc. The quantities of soda solution required to neutralise a given weight of glycerophosphoric acid in presence of helianthine and phenolphthaleïn respectively are as 1 : 2. A method for the estimation of the acid is worked out from these data.—Heat of neutralisation of glycerophosphoric acid, by MM. H. Imbert and G. Belugou.—New results relating to rachitis, by M. Œchsner de Coninck.—On species in botany, by M. Paul Parmentier—On polymorphism of branches in inflorescences, by M. H. Ricome. Branches of many inflorescences show differences among themselves. In branches in which the direction is near the vertical, the symmetry is normal. In branches much inclined to the vertical, this symmetry is more or less disturbed.—On the geology of the islands of Metelin, Lesbos, and Lemnos in the Ægean Sea, by M. L. De Launay.—On an apparatus generating leucocytes observed in the peritoneum, by M. J. J. Andeer. The peritoneum is the starting-point for the ostiolic apparatus of the whole animal. It is here shown that the peritoneum is also the starting-point for the genesis and formation of the elements of the blood.—Cholesterin and the biliary salts as a chemical vaccine against snake poison, by M. C. Phisalix. The bile salts exert the same protecting influence against snake poison as the bile itself.—On the entozoa of man in Normandy, by M. Ed. Spalikowski.

AMSTERDAM.

Royal Academy of Sciences, October 30.—Prof. van de Sande Bakhuyzen in the chair.—Prof. J. C. Kapteyn on the velocity with which the solar system moves in space. This velocity is deduced from the velocity in the line of sight of fifty-one stars measured by Vogel. It was demonstrated that from these velocities the sun's motion can be deduced with a weight more than seven times as great as that of the determination made by Vogel himself, if the ratio of the average velocity of the stars to that of the sun, previously communicated to the Academy, be made use of. Prof. Kapteyn found for the velocity of the system 10·4 ± 0·7 miles per second. From this, in connection with a previous communication, is further deduced the mean

parallax of stars of different magnitude.—Prof. Hubrecht presented for publication in the *Proceedings* a paper by Dr. G. C. J. Vosmaer, of Utrecht, entitled "On the retrograde development of the blood-vessels in the omentum of the rabbit," and showed by means of camera sketches of the omen of rabbits (new-born, one day, four days, eight days) that Ranvier's "cellules or réseaux vasoformatifs" are the last remnants of a process of retrograde development of vascular tissues in this membrane.—Prof. Bakhuis Roozeboom on an inquiry made by Dr. Mohr into the behaviour of solutions of $NH_4Cl + FeCl_3$, on crystallising out. Besides the well-known double salt $FeCl_3.2NH_4Cl.H_2O(D_1)$, there were detected: $FeCl_3.NH_4Cl(D_2)$ and $2FeCl_3\ NH_4Cl.4H_2O(D_3)$. They were obtained by a new method of evaporation at a constant temperature in a desiccator under the microscope. Some solutions, which precipitate D_1 on evaporation, dissolve it again, when the evaporation is prolonged. The mixed crystals, which can also be precipitated from certain solutions, probably contain Fe as D_1.—On behalf of Dr. Cohen the speaker made a communication to the effect that the irregularities observed in the Weston-element (Clarke's, with the substitution of cadmium for zinc) had been found to be caused by a transformation which solid cadmium sulphate undergoes at 13°. It suffices to heat the element a little above this temperature to restore its normal behaviour.—Prof. van Bemmelen presented, on behalf of Dr. Klobbie, a paper on equilibrium in the water-ether, water-malonic acid and ether-malonic acid systems, and the isotherm of the water-ether-malonic acid system at 15°.—Prof. van der Waals communicated, on behalf of Dr. P. Zeeman, a third paper on doublets and triplets produced by external magnetic forces. Dr. Zeeman, working with a Rowland grating, has succeeded in photographing the outer components of the magnetic triplet, the light of the central component being quenched by means of a Nicol. The negatives obtained in this manner, and specimens of which were shown at the meeting, are particularly adapted for measurements concerning the magnetic change. Measurements of one of the blue cadmium lines have given for e/m the value $2,\ 4 \cdot 10^7$. The experiments are being continued.—His inquiries into the action of nitric acid upon methyl amides have occasioned Prof. Franchimont to study also the action of nitric acid upon methyl nitramines, and he has found that even below 0° nitrous oxide and methyl nitrate are formed nearly quantitatively, which is more easily deduced from the formula $CH_3.NH.NO_2$ than from

$$\underset{\diagdown\,\diagup \atop O}{CH_3.N—NOH}$$

. Methyl nitramine does not produce blue, violet, or green colorations with ferric chloride, though under certain circumstances a reddish-brown ferric salt may be obtained from it. Prof. Franchimont further presented, on behalf of Mr. P. van Romburgh, a paper on the occurrence of certain volatile products in tropical plants. Mr. van Romburgh has already examined more than 900 genera and found methyl alcohol in many of them, acetone in some of them, but methyl salicylate in many more of them, viz. in 18 per cent. of the number examined. Sometimes it occurs together with prussic acid. The volatile reducing substance described by Reinke and Curtius was also often detected and obtained as a liquid from indigo, rameh, and the leaves of sugar-cane.—Prof. Lorentz on the question of the relative motion of the earth and the ether. Remarks on a recent memoir by Prof. A. A. Michelson (*Amer. Journ. of Science*, ser. 4, vol. iii. p. 475). The author discusses the assumptions that are necessary in the theory of aberration.—Prof. Stokvis presented the dissertations of Mr. J. Keyzer, entitled "Ueber Haematoporphyrin im Harn," and of Mr. J. de Hartogh, jun., entitled "Ueber Peptonurie und den Nachweis des Peptons im Harn," and added some oral elucidations.

New South Wales.

Royal Society, October 6.—The President, Henry Deane, in the chair.—Note on mutilations practised by Australian aborigines, by T. L. Bancroft. The paper dealt with the object of the "Mika" or "Kulpi" operation of the Australian aborigines.—On a cordierite-bearing rock from Broken Hill, by J. Collett Moulden. This is believed to be the first time that cordierite has been recorded in Australia. It has a somewhat extensive development in the metamorphic rocks of Broken Hill, and is described in detail from two parallel exposures of granulitic rock about half a mile S.E. by E. from Block 14 Mine. The cordierite occurs in large crystals and also in grains through the granulite.—Note on the occurrence of a nickeliferous opal near Tamworth, N.S. Wales, by D. A. Porter. Several years ago a specimen of opal brought to the writer was said to have been obtained in the "Never-never" ranges on the head waters of Attunga Creek, and not far distant from Mount Gulligal, Parish of Attunga, County of Inglis. Some little while ago, being in the vicinity, Mr. Porter found the locality and secured a few small specimens, one of which he forwarded to be exhibited before this Society. The mineral occurs in the form of small veins in serpentine rock, and is accompanied by veins of a pinkish or salmon coloured chalcedony, exhibiting a porcelain-like texture and broken surfaces.—Icebergs in the Southern Ocean, No. 2, by H. C. Russell, C.M.G., F.R.S. This paper was prepared as a continuation of one read before the Royal Society, September 4, 1895. It deals with the reports of icebergs seen since the end of July 1895. One hundred and two ships have reported ice in the interval; nearly the whole of the ice, so reported, was within the area enclosed between 40° and 86° east longitude and 40° to 62° south latitude; very few reports of ice outside that area have been received. It was shown that the *Thermopylæ* steamed for 1000 miles amongst icebergs, and that the ocean was clear one hundred to one hundred and twenty miles north of this track. Some idea of the number of icebergs may be gathered from the fact that the officers of one ship counted 977 bergs, and those of another ship 4500. This and the previous paper cover a period of six years, and it was shown that at times the icebergs come into, or leave the track of vessels in a few days; three instances in which there had been sudden disappearances were shown to be coincident in point of time with the advent in Australia and the ocean between the Cape and Australia of strong north to north-west winds.

BOOKS RECEIVED.

Observational Astronomy: A. Mee, 2nd edition (Cardiff, *Western Mail*).—Annuaire Astronomique, 1898: C. Flammarion (Paris, E. Flammarion).—Catalogue of the Madreporarian Corals in the British Museum (Natural History): H. M. Bernard, Vol. 3 (London).—Annals of the Cape Observatory, Vols. 3, 6, 7 (Darling).—Ambroise Paré and his Times, 1510–1590; S. Paget (Putnam).—Model of a Locomotive: C. Volkert, translated (Philip).—26th Annual Report of the Local Government Board, 1896–97 (Eyre).—Solutions of the Exercises in Taylor's Euclid, Books vi–xi.: W. W. Taylor (Cambridge University Press).—Elements of the Mathematical Theory of Electricity and Magnetism: Prof. J. J. Thomson, 2nd edition (Cambridge University Press).—The Steam Engine and other Heat Engines: Prof. J. A. Ewing, 2nd edition (Cambridge University Press).

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THURSDAY, DECEMBER 30, 1897.

MOTIVE POWER AND GEARING.

Motive Power and Gearing for Electrical Machinery. By E. Tremlett Carter, C.E., M.I.E.E., &c. Pp. xxii + 620. (London: *The Electrician* Printing and Publishing Company, Ltd.)

MR. CARTER has written a very interesting and very useful book on a subject of much importance for electrical engineers. The needs of electrical practice have had a great effect in stimulating the invention of quick-running steam engines, the improvement of gas engines, and the discovery of modes of transmitting power from the driving machine to the driven which did not formerly exist. An electrical engineer is all the better electrical engineer for being also a good mechanical engineer; but as he must master (if he is to be anything but the veriest rule-of-thumb mechanic) in the course of his training in the class-room and the workshop, a very considerable body of more purely electrical knowledge and practice, and, over and above, acquire some knowledge and experience in mechanical matters, the latter is the point in which, when starting on his practical career, he is apt to be most deficient.

Of course, for making all these things realities to a man, there is no education for the engineer like that of the workshop, provided his theoretical training in the principles of the scientific work he is to do (for scientific it ought always to be, or he is no true engineer), is carried on at the same time, just as for the scientific study of physical science there is no training like that of the laboratory carried on parallel with systematic discussion of physical theory and experiment in the lecture-room.

The electrical engineer, as we have observed, however, if properly trained, has always an inquiring spirit, and an observing eye, and an adaptability of self to circumstances, which enable him as he goes on in his work, and comes into contact with the considerable diversity of machinery which it is his lot to encounter, to gradually become a mechanical engineer of great resource and skill so far, at any rate, as his own department of work is concerned.

A book like Mr. Carter's, studied in connection with workshop practice by a capable man, or kept on the shelf in the dynamo room to be read and consulted when time or the requirements of work present opportunity, cannot but be of great service. The topics dealt with are many and various, and an enumeration of them would more than occupy all the space at our disposal, though it would bring out very clearly how great is the range of mechanical question and device with which the electrical engineer is now concerned.

The first chapter deals with fundamental principles, such as motive power, work, energy and its sources, inertia, waste power and useful power, load and load diagrams, dynamometry (more properly ergometry), and storage of energy. The order of treatment differs somewhat from that which in a complete discussion of such subjects would be regarded as logical, but it is, so far as it goes, quite scientific, though the ideas referred to are occasionally so general as to require a good deal of special discussion and elucidation, which of course must be obtained elsewhere.

In the discussion of reciprocating (or simple harmonic) motion, it would have been well to insert besides the statement that the numerical ratio of the acceleration to the displacement is a constant, that the value of this ratio is $4\pi^2/T^2$ where T is the period of the motion. This is a simple rule which is of real service in dealing with vibrations. The phrase "elastic forces of inertia" seems a little strange to the pure physicist; but of course what the author is insisting on, is the give and take action of a body, which in consequence of its inertia stores up energy in an accession of speed, and restores it again when the speed is diminished.

A beginning is made in this chapter of the important subject of the measurement of power. One or two forms of brake and of transmission dynamometer are described, and the general principles discussed, the further treatment being left till the systematic application of tests comes under review.

In this chapter also, it ought to be mentioned, the author treats of economy of design. Lord Kelvin's law of economy, though acted on to some extent, is not yet, it is to be feared, fully appreciated and acted on. It says really that improvement cannot be economically carried beyond the point at which the proper annual charge for the capital invested in an improvement of plant, is just equal to the annual saving effected by making it. Here is a point, of course, at which increase in the cost of materials and labour retards, and diminution in the same facilitates, improvement in design.

After a statement of the problem to be solved, which he puts in the form, "What are the best provisions which may be made for utilising the available energy for the performance of useful work and the production of a paying revenue?" the author proceeds to deal with the steam engine. This forms Part ii. of the work, and is treated under the headings: Fuels, thermodynamics, principles, steam, furnaces and boilers, theory and action of the steam engine, steam engine details, some typical steam engines, steam engine driving, the steam engine in relation to electric power, the management of steam plant.

After this enumeration of chapters, it will not appear surprising that this part comprises more than half the book by some twenty-two pages. All the chapters seem to us full of practical information, and of great value to electrical engineers. The sketch of thermodynamics given is perhaps that which is most directly open to criticism, not so much on account of what is included as of what is left out. There are, however, one or two points on which we would offer one or two slight remarks. First it would be well always, if the phrase "perfect gas" is to be used, to offer some direct definition of its meaning. Mr. Carter does so in his p. 73. Practically what he defines as a perfect gas is one which, under all conditions, fulfils the characteristic equation $PV/T = \text{constant}$. But in the definition of T there seems a little looseness. Thus it is stated (same page), "taking the zero on the Fahrenheit scale as the standard it was found by Charles, that all gases expand 1/460 of their volume at this temperature when raised from any temperature to a temperature 1° F. higher." Then from

this increase of volume for each degree of the F. scale it is inferred that the absolute zero is 460° F. below the ordinary zero. Logically this process is deficient in that it presupposes a known Fahrenheit scale; and there were just as many perfectly exact Fahrenheit scales as there were previously existing exactly made Fahrenheit thermometers. Our impression is that the law of Charles or Gay-Lussac expressed the fact that the different gases experimented on, all expanded by nearly the same fraction of their volume at the temperature of melting ice on being raised under constant pressure from that temperature to the "boiling point" of water. Then *this* expansion (from v_0 to v_{100} say) obtained accurately for any one gas enables $t°$ C. to be *defined* for *that* gas as thermometric substance as that temperature for which the volume of the gas under constant pressure is $v_0 + t(v_{100} - v_0)/100$, and so also for the Fahrenheit scale. Taking air, we get by this definition the air thermometer scale, which, having its own independent definition, can be used as a standard of comparison for other thermometric scales.

From this we get the absolute zero on this gas thermometer scale as that for which $t = -100\,v_0/(v_{100} - v_0)$ that is for which the volume of the gas is zero. Fulfilment of Boyle's law, if it exists, gives agreement of the similarly, but independently, defined constant volume scale for the same gas with the constant pressure scale. Thus we get an independent scale for each gas for which accurate experimental data are available, and the *numerical reckoning* of the absolute zero of temperature will not be necessarily the same for all. We say this with Mr. Carter's note on p. 107 in view. We believe that a perfect gas is best defined as one which obeys Boyle's law at all pressures and temperatures, and gives a constant pressure scale agreeing with the only properly absolute scale of temperature, that of Lord Kelvin, or, which comes to the same thing, as a gas which, besides fulfilling Boyle's law, has an invariable ratio of specific heats.

The second law of thermodynamics is hardly that given on p. 106, which is really the so-called "axiom" on which Lord Kelvin based the second law. The law itself is most shortly expressed by the equation $\int dq/t = 0$, where t is absolute temperature, dq a quantity of heat taken in (or given out) at temperature t, and the integral is taken round a reversible cycle. If t_0 be the lowest available temperature, the positive value which $-t_0\int dq/t$ has for every non-reversible cycle is Lord Kelvin's expression for the heat dissipated in the cycle.

We are rather disappointed that no treatment, *e.g.* the beautiful graphical treatment given by Maxwell, is included of the thermodynamics of change of state. By means of the Protean fundamental parallelogram of the Carnot cycle, the whole of the essential part of thermodynamics can be given in two or three pages. A statement from this point of view of the information which thermodynamic theory gives as to the density of saturated steam would not have been inappropriate here.

The account of furnaces and boilers and of steam engines generally seems very full and complete, but a full review of it is a thing to be undertaken only by an expert in these matters. No one, however, who takes an interest in engineering methods and results, and nothing can be more valuable for the physicist than their study, can fail to be struck with the fulness of the information given by Mr. Carter.

In Part iii. gas and oil engines are discussed, and we have, after a chapter on gaseous and liquid fuel, the Otto cycle, and engines working on this cycle are fully described. This, to us, is perhaps the most interesting part of the book. Prime-movers of this description have advanced immensely during the last ten or twelve years, and the lot of those who have to use them is cast in much pleasanter places. We have a lively recollection of having to toil with five or six enthusiastic laboratory students turning the fly-wheel for nearly half an hour at a time trying to get a large gas engine started. This and other difficulties, and the continual setting to rights which the engine required, would have tried the patience of a saint, and certainly were too much for ordinary mortals.

In Part iv. water motors and turbines generally are discussed, in Part v. gearing is dealt with, and in Part vi. we have a most valuable account of types of power stations.

The book, it ought to be mentioned, is one of several excellent practical works that have appeared by instalments in the *Electrician*. It is very thoroughly illustrated with excellent drawings: engines of all kinds, central power stations, details of machinery, such as valve gear, governors, injectors, &c. Some of these might perhaps have been worked up better, but most are good, and all are thoroughly business-like and intelligible. We regret that we have not space to deal with the work more adequately; but as it is, in fact, a collection of some three or four separate treatises of great value, any attempt to fully review it here is impossible.

We have nothing but congratulation for the author on his work. Electrical engineers are deeply in his debt.

A. GRAY.

A PIONEER OF MEDICINE.

Masters of Medicine. John Hunter, Man of Science and Surgeon. By Stephen Paget, with an introduction by Sir James Paget. 8vo. Pp. 272, with a frontispiece. (London: T. Fisher Unwin, 1897.)

MR. FISHER UNWIN has undertaken to publish a series of volumes dealing with the life and works of the great scientific men who have brought medicine and the allied sciences to their present state of perfection. The object of the series, which is under the general editorship of Mr. Ernest Hart, editor of the *British Medical Journal*, is to set before unprofessional readers a plain account of the lives and fortunes of the "Masters of Medicine," with such a survey of their work as may be necessary to show wherein they excelled.

John Hunter lends himself particularly to this method of treatment. Living only a hundred years ago, the founder of a great school of thought, the hero of a hundred orations by the most eminent surgical minds of the century, there exists plenty of material from which to construct a most readable biography. His life, indeed, has often been written but not always judiciously, for it

is only of late years that the critical spirit, which has reduced the writing of history to a science, has begun to pervade the historians of medicine. Mr. Paget has performed his work excellently, for he has consulted original authorities and has availed himself, by the kindness of Miss Hunter-Baillie, of such documents belonging to the Hunter family as are now in her possession. Fresh light is thus thrown upon some of the more obscure points in Hunter's career, whilst the charming personality of Mrs. Hunter, who selected the words for Haydn's Creation, is brought into bolder relief.

John Hunter, the founder of pathology, or the science which deals with the causes and progress of disease, was one of the younger members of a very remarkable band of pioneers in medicine who were born within a few miles of each other in a remote country district of Scotland, and who flourished in the middle of the last century. First in seniority was Smellie, of Lanark, the great man-midwife; then Cullen, sometime professor of medicine in Edinburgh, born at Hamilton; after him came William Hunter, in some respects greater even than John, his youngest brother; and finally Matthew Baillie, nephew of the Hunters, and the most worthy disciple of his uncles. Smollett, too, was the intimate friend of Smellie, and so must have known the Hunters. It would be of extreme interest to know the factors which led to the production of such extraordinary talent in so circumscribed an area and for so limited a period. In the Hunter family no less than three sons of the ten children were extraordinarily gifted, and in each case their genius was directed towards medical science. That the genius was innate is clearly shown by the fact that John Hunter instantly became an accomplished anatomist, and that although he was an original thinker of the highest power, he was in many respects illiterate, and always had the greatest difficulty in expressing his thoughts in words. Beginning with nothing, John Hunter, after many years of struggle, achieved a foremost place amongst the surgeons of London. But it was by his teaching, rather than by his clinical powers, that he gained his reputation. Edward Jenner, in England, the discoverer of vaccination, and Dr. Physick, who lived to become the veteran exponent of his master's teaching in America, were amongst his house pupils, whilst all the foremost surgeons of the next generation had attended his lectures—lectures which cost his hearers but tenpence a-piece, as Mr. Paget points out, for they were near a hundred in number, the honorarium for the course being four guineas. Yet the lectures were of the most magnificent kind, for they comprehended the whole circle of the sciences round surgery. They were made at a great cost to Hunter, for his brother-in-law, (Sir) Everard Home says of them:

"Giving lectures was always particularly unpleasant to him; so that the desire of submitting his opinions to the world, and learning their general estimation, was scarcely sufficient to overcome his natural dislike to speaking in public. He never gave the first lecture of his course without taking thirty drops of laudanum to take off the effects of his uneasiness. He was so diffident of himself that he trusted nothing to memory, and made me draw up a short abstract of each lecture, which he read on the following evening as a recapitulation to connect the subject in the minds of the students."

It is no wonder, therefore, that the toils of his practice, the cares attending the amassing of the nucleus of the magnificent museum now housed in Lincoln's Inn Fields, and the labours of teaching, early overweighted a body by no means strong. He suffered from angina pectoris for many years before his death, and was wont to say that his life was at the mercy of any rascal who chose to irritate him, and he was very irritable. He died suddenly at St. George's Hospital, October 16, 1793, on the same day, and perhaps at the same hour, that the unfortunate Marie Antoinette, Queen of France, was beheaded in Paris. He was buried in the vault of St. Martin's-in-the-Fields, whence the pious care of Frank Buckland rescued his remains in 1859, and they were re-interred in Westminster Abbey.

Mr. Paget has performed his task most excellently, and if the present volume is to be taken as a standard for the series the sale should be large. Not only is the book well and pleasantly written, abounding in anecdote, but it is most tastefully produced, so that the paper, the print, the binding, and the reproduction of a part of Sir Joshua Reynolds' portrait of Hunter are in every way admirable.

SELECTIONS FROM A DIARY.

The Journals of Walter White, Assistant Secretary of the Royal Society. With a preface by his brother, William White. Pp. vii + 285. (London: Chapman and Hall, Ltd., 1898.)

MOST of the Fellows of the Royal Society of more than twelve years' standing will retain a lively recollection of Mr. Walter White, whilom Assistant Secretary to the Society, and will look with interest into the present volume. Mr. White entered the service of the Royal Society in 1844, and in 1861 (not, as incorrectly stated in the preface, in 1853, "less than ten years") was appointed Assistant Secretary, which office he held until 1885. During this long period he had unusual opportunities of watching the inner working of the Society, and thus the development of scientific ideas and activities; and the reader of the diary of so shrewd and observant man as he was, would naturally expect to learn much. We are compelled to say at once that such expectations will not be fulfilled.

The first chapter, which contains entries in the diary up to the time of his attaining a post at the Royal Society, is interesting as showing how a man, brought up as a cabinet-maker, after pursuing diligently his trade for some years, by continued intellectual toil, bravely teaching himself, won his way, amid many discouraging circumstances, to a means of livelihood more congenial to his nature. It will probably surprise many of the Fellows of the Royal Society to learn that one whose great knowledge of languages and literature had often been of help to them, had spent so many of his earlier years at the joiner's bench.

The third chapter puts together a number of entries illustrating Mr. Walter White's intimacy with the late Lord Tennyson. From one of these entries we gather that it was a suggestion from Mr. Walter White which led the poet eventually to build a house at Haslemere.

The second and fourth chapters contain, together with

other matters, entries relating to the Royal Society and science, the former chapter dealing with the period from 1844 to 1861, when Mr. White became Assistant Secretary; the latter with that from 1861 to 1884, the year before he ceased to hold office. The forty years which these two chapters cover were years in which science made remarkable strides, and years also during which important events took place within the Society. Mr. Walter White was literary rather than scientific in his leanings; still the records of the impressions made by the successive exposition of new scientific ideas upon one who listened to them in turn, near at hand, during so long a series of meetings of the Society could not fail to be interesting. We are told in the preface that the present volume is not the whole diary, but only selections from it. It is to be regretted that what has been published contains so little dealing with the weighty matters of science brought before the Society during the forty years, or with the effects produced by new ideas on those who were the first to listen to them. It is still more to be regretted that the selection has been so largely confined to matters which cannot justly be called by any other name than tittle-tattle and scandal. From his position Mr. Walter White was to a large extent a confidential servant of the Society. The Fellows were in the habit of talking to him freely, and often expressed themselves concerning scientific things and scientific persons in a familiar and unguarded manner. There could be no harm in Mr. Walter White writing down for his own delectation sayings which pleased him on account of their picturesque force, such as Mr. A.'s account of Dr. B.'s opinion about Prof. C.'s works and ways; but it is to be exceedingly regretted that Mr. William White should have thought it desirable to give publicity to gossiping statements, redeemed neither by wit nor by accuracy, the appearance of which can do little more than give pain to the living, or to the friends of the dead whom they concern. We hasten to add, lest the above remarks should excite curiosity, that the gossip in question will yield very little amusement where it does not give offence. We may add that the volume does not do justice to Mr. Walter White himself any more than it does to the leading men of science and the Royal Society; their conversation with him did not consist chiefly in finding fault with each other, nor was his chief delight in listening to them, and taking notes of their angry or idle words.

OUR BOOK SHELF.

Agricultural Chemistry. By R. H. Adie, M.A., B.Sc., and T. B. Wood, M.A. 2 vols. Pp. ix + 280, and vii + 229. (London: Kegan Paul and Co., Ltd., 1897.)

IN the preface this is described as an elementary text-book of chemistry, designed for students beginning the study of agricultural science, and adopting as its method the teaching of the subject by experiment. The book demands some attention, as it is written by the teachers of agriculture in the University of Cambridge.

We are often told that the only right way of teaching chemistry is by leading the student to be himself the discoverer of chemical facts and laws by a series of experiments, observations, and inferences. This method is certainly excellent as an introduction to the science, but it becomes too cumbersome as the scholar proceeds, and the teacher soon finds himself making important statements of which no demonstration is forthcoming. Nor are all parts of the science best learnt by the exhibition of experiments. It is, indeed, easier to learn grammar as grammar, than to discover grammar for ourselves by the analysis of a language.

The first of these small volumes is intended as an introduction to general chemistry; the second deals with the subjects of soil and manures, with a briefer reference to the constituents of plants, and the analysis of foods.

It is difficult to tell in what manner the book is intended to be used. The details of the experiments are often so imperfectly described, that it would be impossible for a student to perform them without further directions. The preface states that the book is especially intended as an aid to teachers; but if the teacher is to follow the course marked out, he must clearly have a great deal of other information to fall back upon. One cannot, however, resist the conclusion that a great many of the experiments mentioned are not meant to be performed, but merely to be talked about.

We need hardly say that a good deal of correct teaching is given, but the errors and deficiencies are not a few. R. W.

Notions générales sur l'Écorce terrestre. Par M. le Prof. A. De Lapparent. 8vo. Pp. 156. (Paris: Masson et Cie., 1897.)

GEOLOGY can be made attractive enough by a good writer who divests the subject of those details which concern only the specialist. To learn the aims of the science and its main results are all that the general reader and the elementary student require; and it is well when, as in the present little work, a distinguished master is not only willing but able to produce such a sketch agreeably written as well as instructive. The subject is introduced in the course of six lessons, and the author, in the first place, deals with the early history of the globe, with seas and continents, and the external features of the earth in general. He passes on to consider various questions of physical geography, and the erosion of the land by rain, rivers, and sea. His remarks on the cutting away of river-courses so as in time to produce a *profil d'équilibre* are illustrated with reference to the Seine, which has excavated its channel almost to the lowest possible level throughout its main course. The method of accumulation of various sediments, and volcanic phenomena are next discussed. Upheavals and depressions and the sequence of rocks form the subjects of another lesson. Some account of the Paris Basin is given, and in conclusion there is a brief description of the principal geological formations. The work is illustrated by thirty-three figures of fossils, sections, and photographic reproductions. Among the fossils only the principal forms of life are indicated, such as a Sea-urchin from the Chalk, a Devonian Spirifer, Jurassic Ammonites, and a Fossil Bird. The student's mind is therefore not burdened with many names, but a perusal of the work will give him a clear general grasp of the principles and elements of geology. H. B. W.

The Dawn of Civilization: Egypt and Chaldæa. (Third edition.) By G. Maspero. Pp. xiv + 800. (London: S.P.C.K., 1897.)

THE third edition of "The Dawn of Civilization," the English translation of Prof. Maspero's "Les Origines," has just been issued. The three coloured photographic plates which were inserted in the second edition are here retained, while but few changes have been made in the text of the second edition of the work. The most considerable addition appears to be in the chapter dealing with the first Theban empire. Here the author

gives a brief sketch of the conclusions that may be drawn from a study of the remains recently found by Prof. Petrie between Ballas and Naqâda. Towards the end of the sixth dynasty the Libyans, yielding to a migratory impulse, overran the western frontier and established themselves in Egypt, leaving a permanent record of their presence in the burying places and remains of villages which extend the whole length of the mountain chain from Siût to Gebelên. Prof. Maspero does not go so far as Prof. Petrie, who would regard the whole of the south of Egypt as having been wrested from the native kings by this "new race"; he does, however, conclude that these Libyan settlers were predominant throughout a considerable area on the left bank of the river, and that their influence was felt for more than a century. The pagination remains the same as that of the two earlier editions of the book.

The Local Distribution of Electric Power in Workshops, &c. By Ernest Kilburn Scott, A.I.E.E. Pp. 137 + viii. (London: Biggs and Co.)

THE advantages of electric transmission of power in factories and workshops are not so well known as they might be, or the electric driving of machinery would be more extensively adopted than it is. Wherever electric motors have been made to do duty in machine shops, complete success has been attained, but it is only in late years that engineers and proprietors of factories have learned to make use of electric driving to any great extent. Lately, however, this branch of electrical engineering has been coming to the front, and it promises to develop into the most important branch of electrical work, electric lighting not excepted.

The information brought together by Mr. Scott will show manufacturers what has been done, and what electric motors are capable of doing. The advantages of electric driving, both economically and commercially, are clearly pointed out, and detailed particulars of power required by various machines are given. The advantages and disadvantages of alternating currents from the point of view of power distribution in factories are discussed, and there are descriptions of the various points of a power installation, with examples of the most recent practice. The book is thus one which should be in the hands of all who are concerned with the applications of electricity to the machines and tools of workshops and factories.

Memory and its Cultivation. By F. W. Edridge-Green, M.D., F.R.C.S. (International Scientific Series.) Pp. 307. (London: Kegan Paul and Co., Ltd., 1897.)

DR. EDRIDGE-GREEN considers that the human mind is divisible into "ultimate faculties," a list of which he gives. Of these "ultimate faculties" some thirty-seven are assigned to this position with certainty. Dr. Green has no doubt whatever about their fitness to be considered "ultimate faculties," although amongst them are such qualities as Causality, Alimentiveness, and Inhabitiveness. Others there are, such as Vitativeness and Human Nature, whose position as ultimate faculties of the human mind is still *sub judice*. Dr. Green might, we think, have postponed the publication of this book until he had made up his mind about them. Part of the book is devoted to the description of a system of cultivating the memory; but there is the best possible evidence that either Dr. Green does not himself utilise this system, or the system is worthless. He would certainly never have published a work on psychology without acquainting himself with the present state of knowledge upon the subject. Yet he has forgotten the whole of his psychological studies as completely as if they had never existed. If his system were one for cultivating the art of forgetfulness, and were a perfect system, the result could not be more complete.

Illusions and Hallucinations. By Edmund Parish. Pp. xiv + 390. (London: Walter Scott, Ltd., 1897.)

THIS is a very thorough account of the subject, in fact it is, perhaps, for the series to which the book belongs, almost too thorough, and the general reader may find some difficulty in getting a clear account of the author's views out of the mass of detail. The conditions of fallacious perception are fully considered, and the general phenomena are referred to disturbed association. The author gives new definitions of illusion and hallucination, the former being supposed to depend on the suppression of certain processes which normally intervene between the immediate sensory change and the perception process, while hallucination is referred to forced association. These definitions have the advantage that they refer both phenomena to a common cause, *i.e.* to dissociation of centres normally acting together; but they are open to the objection that they are based on purely theoretical and uncertain views, and it would probably be better to retain the old definition depending on the existence or non-existence of an external stimulus while recognising that there is no hard and fast line between the two conditions. There are two interesting chapters on the results of the international census of waking hallucinations. The author brings forward much evidence that the real nature of the "waking state" in most cases was one of abnormal dissociation. He criticises adversely the evidence for telepathy derived from the census, which was regarded as valid by the authors of the English Report. He brings forward from the Report itself evidence against this conclusion, and in regard to the supposed positive evidence, he lays great stress on the importance of similarity of association of ideas in the two cases. Among many other interesting points, only one can be mentioned here, viz. the criticism of the view that the negative hallucinations of hypnotism depend on suggested inattention. The author points out that an object may be made by suggestion to appear smaller and smaller, till it finally disappears. In this case, according to the theory, a phenomenon due to concentration or special direction of attention would be suddenly replaced by one due to lack of attention.

Transactions of the Rochdale Literary and Scientific Society. Vol. v., 1896–97. Pp. 90 + xxii. (Rochdale: James Clegg, 1897.)

BY publishing the papers in this volume the Council of the Rochdale Literary and Scientific Society brings the work of the Society into prominence, and assists in making the objects of the meetings known to a wider circle. The volume is as interesting as its predecessors, and is a creditable addition to local literature and science. Among the papers contained in the vol... is a chatty account of "Men and Manners in Manila," by Dr. A. Jefferson, an elementary description (with figures) of "Egyptian hieroglyphics, picture-writing, and the English alphabet," by Mr. C. Heape, a brief note on some graphite and flint implements found in a neolithic store near Rough Hill, by Mr. W. H. Sutcliffe, and a paper on the geological history of the Cephalopoda, by Mr. Charles Wardingley.

We see from the report that a number of other papers, not included in the present volume, were read before the Society during the nineteenth session, and several very instructive lectures were delivered. The Society, appears, indeed, to be a centre of light and leading in Rochdale.

Les Constantes Physico-Chemiques. By D. Sidersky. Pp. 207. (Paris: Gauthier-Villars et Fils. Masson and Cie.

M. SIDERSKY has already contributed a volume on polarisation and saccharimetry to the Aide-Mémoire series in which the present book appears. The constants herein described are dealt with in a similar manner; they

include density, change of state, viscosity, capillarity, indices of refraction, calorimetry, and photometry. For each of these constants, the author briefly describes the most exact and convenient methods of determining them, and gives in tabular form the results of observations made on various substances. In the descriptions of methods of experimentation, preference is given to those which are actually used in practice outside the physical laboratory, so the book will be a real aid in technical work. Physicists and physical chemists will find the volume a handy epitome of methods and results.

By Roadside and River: Gleanings from Nature's Fields. By H. Mead Briggs. Pp. 204. (London: Elliot Stock, 1897.)

"THE hand of destiny has scattered broadcast through the land the seeds of hope, and yet how many of them all have reached the harvest of ambition." If we rightly understand the purport of these opening words of the preface, the author is expressing some anxiety as to the fate of his literary efforts, and wondering whether his work will be appreciated. We wonder also what becomes of the host of books like this one, well printed and daintily produced, but amorphous in structure, and having no particular aim. There are, we suppose, people who enjoy reading insipid remarks based upon casual observations of nature, and to their kind attention we commend this book. A scientific mind soon wearies of trying to pick out the slender threads of fact which meander through the mass of sentiment.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Dugong.

IN the Hakluyt Society's last book, "The Christian Topography of Cosmas, an Egyptian Monk" (London, 1897), there are some interesting notices of "Indian Animals" with figures, copies of those in "the Florentine Codex"; which, in their turn, *may* have been "drawn by Cosmas himself (or under his direction)," according to an excellent modern critic.

In one passage Cosmas says "the flesh of the turtle, like mutton, is dark-coloured; that of the dolphin is like pork, but dark-coloured and rank; and that of the seal is, like pork, white and free from smell."

For reasons too long to give here, I suppose Cosmas' "seal" (phoke) to be the dugong; (halicore), which is generally described as very eatable; but I cannot anywhere find its colour, as meat, described.

"Potted dugong" from Queensland was on the London market not long ago; and I tried it, once. It was much of the colour of potted tongue.

The figure is more like a conventional sea-horse than anything else, and cannot be relied on much. It is, perhaps, a little less unlike to a dugong than to a seal.

The confusion of dugongs with seals still exists amongst seamen; though, of course, dying out amongst officers.

W. F. SINCLAIR.

Potato-Disease.

IN the "Life and Letters of Charles Darwin," Darwin writes as follows:—

"Mr. Torbitt's plan of overcoming the potato-disease seems to me by far the best which has ever been suggested. It consists, as you know from his printed letter, of rearing a vast number of seedlings from cross-fertilised parents, exposing them to infection, ruthlessly destroying all that suffer, saving those which resist best, and repeating the process in successive seminal generations" (vol. iii. p. 348).

Can any of your readers inform me whether the plan was ever carried out, and if so with what amount of success?

Newcastle-on-Tyne, December 11. G. W. BULMAN.

THE PREVENTION AND CURE OF RINDERPEST.

IN the second fortnightly number for October of the *Agricultural Journal* of the Cape of Good Hope is given a long report of a Conference between the Hon. Mr. Faure, Minister for Agriculture, Mr. Hutcheon (C.V.S.), Dr. Turner, Dr. Edington and Dr. Kolle on the question of inoculation against rinderpest. This account is followed by the Resolution of Conference, by a letter from Dr. Edington and by one from Mr. Hutcheon, in the latter of which is given a review of the different methods of inoculation now used for the purpose of obtaining a certain degree of immunity against rinderpest in the cattle of South Africa. As so many different statements concerning the exact methods used at the Cape by Koch, by Edington, and by Turner and Kolle, and also by Messrs. Danyz and Bordet, have been promulgated, a summary of these various methods may be of interest.

In Koch's method of using the gall obtained from sick animals as a protection against rinderpest, the bile is taken from animals that have contracted the disease by natural infection. It was at first recommended that only green bile and bile free from blood should be used; later this recommendation was modified by Drs. Turner and Kolle, who say "that the difficulty of obtaining good bile has been much exaggerated. If the animals destined to produce immunising gall are injected with a small dose of really virulent blood, say 1 c.c., and are killed at the end of the sixth day of the fever, at least four out of five will give typically good galls, and the gall of the fifth will, in all probability, be fit for use. As a matter of fact, all galls which do not smell, and which are not absolutely red from the presence of a large quantity of blood, can be used without danger by Koch's process"; it is afterwards stated that those galls which have the highest specific gravity appear to possess the highest immunising power. It would appear, however, that the gall-produced immunity is only temporary, and that before long the animals again become susceptible to infection by rinderpest. Another of the great drawbacks to this method of inoculation is the fact that in certain cases the galls appear to contain septic organisms, which not only diminish the immunising power of the gall, but also in some instances seem to have set up a septic condition in the cattle injected.

Applying the method now in vogue in connection with the preservation of vaccine lymph, Dr. Edington added a quantity of glycerine to the gall with the object, first, of preserving for some time the gall in a pure condition, and, secondly, of killing any septic germs which might be present in the gall before it was drawn off from the gall-bladder of the infected animal. Of course it was necessary to use a somewhat larger quantity of this mixture in order to produce immunity. Dr. Edington injected from 15 to 25 c.c. into the subcutaneous tissue of the dewlap. Animals so protected when injected with small quantities of virulent blood, certainly appeared to take the disease in a milder form; in some cases this was accompanied by local reaction and by a rise in temperature, and wherever this occurred there was a marked degree of active and more lasting immunity conferred on the animal. When $\frac{1}{5}$th of a c.c. of virulent blood—that is, blood taken from an animal suffering from an acute attack of rinderpest—was injected, a local reaction was, in most instances, obtained, but in certain cases the preliminary temporary immunity was so slight, that the animal succumbed to the disease set up by the second injection. If, on the other hand, only $\frac{1}{10}$th of a c.c. was used, the local and constitutional reaction was not always obtained, and although a much smaller number of animals succumbed to the contracted disease, a much larger proportion remained susceptible to natural infection. In connection with this bile method, also, it

must be pointed out that when the raw or unglycerinated gall was used as the protecting medium, a certain small proportion of cases contracted severe and even fatal attacks of rinderpest; though whether this was due to the gall itself or to the accidental contamination with virulent blood is not stated in the report, though we should imagine that this latter accident might be by no means uncommon.

Finally, there is the method based on the use of the "anti-bodies" found in the blood of salted cattle, *i.e.* cattle that have suffered from a severe attack of the disease, but have recovered. By injecting gradually increasing quantities of virulent blood into such animals, the anti-bodies appear in still larger proportions in the blood, and can then be used either in the form of a serum solution or as a defibrinated blood solution. This serum may be used to confer such a degree of passive immunity on the animal, that it either escapes the disease altogether, or contracts it in a much modified form; again, the serum may be used to cure an animal in which there is already a rise of temperature accompanied by other signs of a naturally acquired attack of rinderpest.

All these methods have now been used at the Cape, and it may be of some interest to our readers to learn what is the consensus of opinion as laid down in the Resolution of Conference. It is agreed "that inoculation with bile, either pure (Dr. Koch's) or glycerinated (Dr. Edington's), should not be adopted in any district in which it has not already been commenced, as more satisfactory and more permanent results are obtained from the use of serum, and the latter method can be more successfully applied in clean herds than in herds which have been previously inoculated with bile."

The "Conference" then arrive at the conclusion that it is better not to recommend that the inoculation with Koch's bile should be followed by an inoculation with virulent blood on the tenth day, as formerly recommended, as it is found that unless this blood inoculation is followed by a decided reaction—which occurs very rarely—the immunity already conferred by the bile is not increased. It is recommended, however, that in the case of dairy cattle which have already been inoculated with Koch's bile a second bile inoculation may be made, as this will confer a protection for several months, and at the same time will not interfere with the secretion of milk.

The glycerinated bile method should be followed on the tenth day by the inoculation of one-tenth of a c.c. of virulent blood; and although a second blood inoculation fourteen to seventeen days later increases the active immunity in certain cases, its use has been followed by considerable mortality, and the Conference, while not opposing a second inoculation of blood, does not recommend its universal adoption, as it is attended with considerable risk.

There appears to be a decided opinion that serum, when properly prepared, is superior to, and much more convenient for use than defibrinated blood, and its use is strongly recommended in preference to the latter when it can be obtained, though it is also recommended that a certain number of fortified salted cattle —*i.e.* immunised cattle—be sent to districts far removed from centres where serum is prepared, in order that defibrinated blood may be prepared in cases of sudden emergency.

It seems to be the general experience (as in other diseases in which the serum treatment is used) that in healthy herds the use of serum alone does not confer a very permanent immunity; it is therefore considered necessary, in infected districts, to infect healthy animals with rinderpest, and keep the attacks under control by means of the serum. This may be most safely and satisfactorily accomplished by injecting virulent blood subcutaneously on one side of the animal, and serum on the other. If necessary, *i.e.* if the disease takes too active a form, a fresh dose of serum will usually enable the animal to pull through the attack. For all practical purposes, however, it has been found that clean herds, in which there is no disease already, should not be inoculated with serum until the disease makes its appearance amongst them, or in their immediate neighbourhood. The whole of the animals should then be injected, after which, or simultaneously, they may be injected with virulent blood, or be kept in close continuous association with infected animals by kraaling them together every night. In this way the animals become salted or protected; under these conditions the immunity produced is active and of long duration, as opposed to the temporary and passive immunity that is conferred by serum when used alone, and perhaps also by bile. Where bile has already been inoculated, it is no use to inject serum and then virulent blood; for, as already mentioned, the immunity conferred by the bile varies very greatly in degree in different cases. Where such bile inoculation has been resorted to, the most satisfactory course for the owner to pursue is to keep a supply of serum by him and inject all cattle as soon as they are observed to be ill, or as soon as the thermometer indicates a rise of temperature. Where serum cannot be obtained, as already mentioned, the blood from salted cattle may be used. These salted cattle are usually fortified by injections of virulent blood, commencing with 10 c.c., and then going to 20, 50 and, lastly, 100 c.c. at intervals of ten days. Either serum or blood is injected in quantities of 100 or 200 c.c. into the animals suffering from the disease. This injection may be made subcutaneously, and not into the muscles, either behind the shoulder or into the dewlap.

It is, perhaps, too early to be dogmatic on the question of the best method of treating cattle for the prevention and cure of rinderpest, but when the exceedingly fatal nature of the disease is borne in mind, and when it is remembered that the disease is so markedly infective and fatal that whole herds are practically exterminated when once the disease is introduced (the objections that are brought forward against inoculation against anthrax, that the percentage mortality from inoculation is almost or quite as great as the percentage mortality from the disease itself not holding good in this case), it is not to be wondered at that the South African farmers received with enthusiasm any method which would preserve to them even a large percentage of their cattle, and that many of them were quite willing to run the risk of introducing rinderpest through the bile inoculation if they could only be sure that some 60 or 70 per cent. of the so infected animals would recover, and would then be protected to a certain degree against future attacks.

As Koch's bile method complied with such conditions it was undoubtedly a marked step forward, whilst it also made it possible to obtain salted cattle with which serum experiments might afterwards be carried out.

These serum experiments—showing that in serum the veterinary surgeon has in his hands a weapon by using which he is able to control the course, even of a severe attack of rinderpest—have given the farmers confidence enough to make them actually anxious to produce the disease under such conditions that they may keep it under control, and so salt their cattle artificially; thus rendering them immune for a considerable period against infection, even of the most virulent character.

With the vast agricultural and cattle-breeding interest at stake, we may anticipate that Koch's earlier experiments will, in the very near future, be improved upon, that South African cattle raisers and dealers will in the long run be enormously benefited, and that a source of wealth, which until a very short time ago was threatened with almost immediate extinction, will continue to be one of the principal resources of a great and flourishing colony.

LARGE REFRACTING AND REFLECTING TELESCOPES.

THE Yerkes Observatory, which has recently been completed and inaugurated, contains in its instrumental equipment the largest refractor in the world, the diameter of the object-glass spanning 40 inches.

The late Mr. Alvan Clark, the constructor of the lens in question, expressed the hope that still larger apertures might be successfully made, but he pointed out that the effect of flexure in larger discs was to be mostly feared, although he felt that it might be perhaps possible to still further increase the aperture without endangering the performance of the objective. Being therefore apparently near the limit to which such large object-glasses can be successfully constructed and mounted, it is only quite natural that attention should be turned to the other form of telescope, namely the reflector, and inquire whether this type of instrument is restricted in the same way as the refractor, or whether it can step beyond these bounds and open up fields which would otherwise be lost to us.

Discussions as to the capabilities of these two types of telescopes have been very rife, and while some observers hold that the reflector is the instrument of the future, others again take the other side and advocate refractors. It is now generally conceded that for definition the refractor is the instrument *par excellence*, but for purposes where light-grasping power is the main requirement the reflector takes the first place. In the cases of very large apertures reflectors can be made of diameters far exceeding anything that can be attempted for refractors. A point of initial importance in large instruments is the question of the focal length of the object-glass or mirror, as the case may be, for on this factor depends the length of the telescope tube. Now if this be of considerable length, the telescope mounting and dome have to be of considerable proportions, rendering the instrument both expensive and subject to many possible errors. To retain the size of the aperture of the instrument and reduce the focal length is a natural means of overcoming this difficulty, and this has been attempted in many instruments. Such a reduction is, however, accompanied by several optical drawbacks which detract from the efficiency of the instruments.

In the case of reflectors of large aperture and very short focal length a most striking deficiency becomes apparent, and, curiously enough, this has practically been passed unnoticed until Prof. Schaeberle (*Astr. Journal*, vol. xviii. No. 413) quite recently brought attention to it. So large is this source of bad definition, that he refers to it as a "fundamental optical defect." How he came to alight on this source of blurring factor will be best gathered from the following brief extract in his own words.

"On a very favourable night, I recently had the opportunity of testing the great Crossley reflector of the Lick Observatory, and found the surface of the same to be a practically perfect paraboloid of revolution; but on examining certain celestial objects—Saturn among others—I was very much surprised to find that the instrument failed most signally to come up to expectations. While puzzling and pondering over the probable cause of the poor results given by what I knew to be a finely figured surface, it occurred to me to ascertain the exact amount of the error introduced in the form of the image, resulting from the well-known fact that the focal point is not at the centre of curvature of the parabolic mirror."

To understand the origin of this bad definition, one must imagine a small circular disc situated in the focal plane of the paraboloid of revolution, and concentric with the optical axis. Viewing this disc from different points on the surface of the mirror, it is obvious that it will appear circular only when the eye is in the optical axis, but in all other positions it will appear elliptical, the eccentricities of the ellipses becoming greater the further the eye is moved away from the optical axis. Further, the angular diameter of both axes of the disc will decrease as the eye moves away from the optical axis, in consequence of the increase in distance from the focal point. The result of such a source of error as this would be that if the rays from the components of a double star be reflected by the mirror, the linear distance between their focal images as formed from different areas along any radius of the mirror will vary from a minimum for the area on the optical axis to a maximum for that area furthest away. In the case of a planetary disc, there will be produced a blurring effect caused by the numerous images of different sizes overlapping one another.

Having investigated this source of error, Prof. Schaeberle made a comparison of the efficiency of the more prominent reflectors now in use. The result is of such interest, that we must refer to it at some length.

In the following table the blurring effect for each mirror is tabulated in the fourth column, the fifth and sixth columns representing the computed difference of angular diameters of the outer ring of Saturn and the solar or lunar disc based on the given ratio of diameters.

Reflector	Diam. of mirror $= 2Rm$	Focal length $= F$	Max. ratio of diameters $= \frac{a}{r}$	Diff. of angular diameters for the given ratio		Limiting radius of field for best definition
				Saturn's outer ring	Sun or moon	
	Feet	Feet		″	″	″
Lord Rosse	6·0	55 0	1·0033	0·13	6	15
Common	5·0	27·0	77	0·31	14	7
Lassell	4·0	37·0	22	0·09	5	22
Melbourne	4·0	28·0	39	0·16	7	13
Paris	3·9	23·4	51	0 20	9	9
Crossley	3·0	17·3	57	0·23	10	9
Draper	2·4	13·0	64	0·26	12	8
Lassell	2·0	20·0	19	0 08	3	25
Roberts	1·7	8·2	78	0·31	14	6
Common	1·7	3·7	404	1·62	73	1
Schaeberle	1·5	12·3	28	0·11	5	19
Draper	1·3	13·0	19	0·08	3	25
Schaeberle	1·0	3·7	141	0·56	25	4

The last column gives the values for the limiting radius of the field of view of best definition for each telescope, on the assumption that the radius of the field of measured distances with the optical axis as centre, does not exceed a value which would introduce an error of more than 0″·05. The most striking feature of this column is the smallness of the fields in the several cases mentioned which are not influenced by this error.

A glance down the fifth column brings out clearly the fact that the smaller the ratio of focal length to diameter of mirror, the larger the difference of angular diameter of the objects observed. Thus in the case of the Draper, Schaeberle, and the two Lassell instruments, where this ratio is comparatively large, about 9 : 1, the differences are small, while for the two Common mirrors and Schaeberle's 12-inch, where the mean ratio is approximately 4 : 1, the differences increase very rapidly.

Not only will this blurring effect, caused by these differences of angular diameters of the images, be notably increased as the focal length is decreased, but the greater diameter of the image, and therefore distance from the optical axis, will bring this defect more in evidence.

The main result of the investigation, summed up in a few words, is that large parabolic mirrors having a ratio of focal length to aperture less than fourteen to one are, as regards definition, "theoretically unfit for making observations of extreme delicacy." It may be mentioned that this defect does not mar the efficiency of such instruments for certain kinds of work, such as spectroscopic, bolometric, &c.

Thus it is gathered from Prof. Schaeberle's investigation that reflectors of large aperture must also be of correspondingly great focal length if the definition of the object to be observed is to be of the first order.

As refractors of large aperture are seldom made of such short focal lengths as are in question, it is unnecessary here to consider the effect of this source of bad definition.

Several interesting points with reference to the capabilities of large instruments have been brought prominently forward during the last few months, and may be appropriately referred to in this place. Thus Prof. Wadsworth (*Astronomical Journal*, vol. xviii. No. 414) has dealt with the efficiency of large refractors for visual observations of planetary details. He finds that from an optical point of view, it is a distinct advantage to increase the apertures of telescopes intended for visual use of planetary detail, such as fine linear markings, up to such a point where the atmospheric aberration will amount to about one-seventh or one-eighth period under the best conditions of observation. If this point be exceeded, then no advantage is obtained, the efficiency actually falling off; the tendency is for the faint lines under observation to be blotted out, instead of becoming more distinct. Indeed so sure is he of this, that he says the limit of efficient size is about reached between 30 and 35 inches, or the limit is very rapidly approached.

Another point of great importance *re* large apertures is that such telescopes cannot always be efficiently used unless the night be very fine and the air still. The well-known observer, Dawes, always used to judge the night by the aperture that could be employed. Thus he spoke of a one-inch night, two-inch night, up to an eight-inch night, this being the greatest aperture he possessed. As a matter of history, one may relate that a comparison of the drawings of Mars made by Sir Norman Lockyer with his six-inch refractor, and by Lord Rosse with his big reflector, showed that although both series were made at the same time, they displayed striking dissimilarities. Dawes, who had also made some valuable drawings at the same opposition, in discussing this question of dissimilarity, concluded that Lockyer's drawings were the more correct, since they were found to be exactly like those he (Dawes) had made, especially with regard to a certain marking which he had called the "double tooth."

Dawes, however, was no lover of large apertures, and on the occasion just referred to he was heard to repeat one of his favourite phrases, "What have the giants done?"

Apart, then, from the quality of the instrument employed, definition depends on the state of the atmosphere through which the light rays pass. On clear nights the question of the movements of the air is of the highest importance, and it is only on this movement that the aperture for any particular night can be gauged. In consequence of these air undulations, which vary in different currents from half an inch to several feet in length, the definition varies enormously.

In the case of a small aperture, and supposing the wave-length to be more than double the diameter of the object-glass, the image of the object under observation would only be bodily moved without confusion; for a large glass the image would be very considerably blurred.

Dr. T. J. J. See has recently (*Astr. Nach.* No. 3455) been making investigations on the sizes and movements of these aerial movements, and his paper on this subject indicates the importance of increasing our knowledge by more systematic study.

Thus it will be seen that in discussing the question of how large telescopes may be made to do useful work, a most important item to take into consideration is the locality in which they will be used. If such a spot be happily found, situated on a high plateau where the movement of the air is practically nil, then theoretically there seems no reason why apertures should be limited in size; but as such a condition as this is rarely if ever to be obtained, a limit is necessarily imposed on the diameters of object-glasses. W. J. S. LOCKYER.

THE WOBURN ABBEY DEER.

FROM the difficulty of obtaining an adequate series of specimens, either living or dead, the deer are one of the groups of large mammals with regard to which our present state of knowledge is decidedly not up to date, comparatively little advance having been made since the appearance of the late Sir Victor Brooke's well-known synopsis in the *Proceedings* of the Zoological Society for 1878. Fortunately the noble owner of Woburn Abbey, who takes a great interest in animals of all kinds, is endeavouring to get together as complete a collection as possible of these beautiful and interesting ruminants, or rather of such kinds as experience shows to be best suited to withstand the vicissitudes of the English climate. With characteristic liberality the whole of the magnificent collection now assembled is accessible to zoologists interested in this group of animals, and by its means considerable additions have already been made to our knowledge thereof. From the extent of ground much larger numbers of specimens of the same species can be collected than is possible in the limited space available in the Zoological Society's Gardens in Regent's Park; and the conditions existing in a large country park are, of course, far more favourable to the well-being and display of the animals than is possible in London.

In the Regent's Park the larger kinds of deer, such as the American wapiti, are generally, from necessity, represented by only two or three individuals at a time, but at Woburn these and other species are assembled in herds of considerable size. And as deer are remarkable for their seasonal variations in coat and colour, it is in such manner only that a full grasp can be obtained of these periodical changes. A further advantage is the opportunity of seeing closely allied species or varieties either in the same paddock or in near juxtaposition; while the facilities for studying the habits of the animals are infinitely in advance of what is possible elsewhere.

For a long period of years the domain at Woburn has been a deer-park where large herds of red and fallow deer wander at their own sweet will; and the undulating wooded ground alternating with level expanses of excellent pasture, and the numerous lakes and ponds dotted over the latter area afford an ideal situation for all animals of this class. Such foreign species as adapt themselves easily to these conditions, and do not make themselves objectionable by developing habits of ferocity, are allowed to run at large in the open park. Among these are Père David's deer, of Northern China, the elk, the Virginian deer, and the Japanese and Manchurian sikas; while muntjacs and roe run wild among the coverts. Such an amount of liberty cannot, however, be permitted to many of the species on account of their dangerous propensities; while it is found convenient or necessary to afford more protection from the wind and weather to yet other kinds. But even in the case of species deprived of their full liberty, the amount of space accorded them is ample, and quite different from what is practicable in domains of smaller magnitude. The American wapiti, for instance, live in a "paddock" of about 150 acres, surrounded by an eight-feet iron fence; and in the same enclosure, as shown in our first illustration, run the various races of sambar, as well as some of the sikas, and various other small species. A small herd of American bison are also among the denizens of this enclosure. Hard by, in a paddock of but little inferior dimensions, is a magnificent herd of

the Altai wapiti, a species first made known in this country by antlers obtained by the second Yarkand expedition in Kashgar, and described by Mr. Blanford. The herd includes the first living examples of this splendid species ever brought to this country, although visitors to the Zoological Gardens have now an opportunity of seeing an immature specimen. And it is not a little remarkable that a stag so well known in the Altai, where it is kept in a semi-domestic condition by the farmers, should so long have remained a stranger to the menageries of Europe.

Perhaps, however, the most generally attractive of all the enclosures is the one which may be called the Chital paddock, on account of its containing a large herd of the beautiful chital or Indian spotted deer. A most successful photograph of a group of deer feeding in this paddock, for which we are also indebted to Her Grace the case, and whereas these animals thrive and multiply at Woburn to an extraordinary degree, some northern species, like the elk and reindeer, which might have been expected to flourish best, die off in an unaccountable manner. Out of several head of American elk only a solitary survivor now remains, while all the adult reindeer are dead. Some young American calves of the latter species have, however, been recently received, and it may be hoped their fate will be happier. Possibly if Norwegian reindeer and elk were tried, they might do better than their American representatives. But it must be remembered that both these animals have disappeared at a comparatively recent date from Britain; and there may be something in our climate at the present time absolutely unfavourable to their existence.

The various Oriental races of sambar and rusa flourish at Woburn equally well with the chital, and the large

Wapiti. Wapiti. Sika. Bison, Wapiti. Wapiti. Sambar.

FIG. 1.—The American Wapiti Paddock at Woburn Abbey, showing Wapiti, Sambar, Sika, and Bison. (From a photograph by the Duchess of Bedford.)

Duchess of Bedford, forms the subject of the second illustration. In addition to numerous chital, easily recognised by their dappled coats, this photograph shows several examples of the true maral, or Caspian red deer, from the Caucasus, which are the largest animals in the photo. This deer, it may be observed, although often regarded as a distinct species, appears to be nothing more than a race, or sub-species, of the red deer of Western Europe. Of the other smaller animals in the group, a Virginian deer occupies the foreground on the left, while several mouflon, and at least one Indian antelope, or black-buck, are in the centre.

From the torrid nature of their environment, it might have been supposed that the Indian chital and black-buck would have been among the species least suitable to withstand our climate. Nevertheless, this is not the series of these animals now collected there affords material for a fairly full study of an exceedingly difficult group. Hog-deer and muntjacs are also among those which are hardy and capable of acclimatisation. Other Oriental species represented in the collection are the swamp-deer of India, and the thameng of Burma and Siam; but these are kept in smaller and well-protected enclosures, with ample shelter. From the colder nature of their habitat, the various species and races of the sikas of Japan and Northern China might naturally be expected to do well, and as a matter of fact this has been found to be the case. In addition to the common Japanese and Manchurian sikas, the collection includes the large and handsome Pekin sika, previously known only by the type specimens sent home by the late Consul Swinhoe after the sack of the Imperial Summer Palace. Père David's deer has been already mentioned as among

those running at large in the park, and there is good prospect of the herd of this aberrant and interesting species increasing in number. A solitary male of the previously imperfectly known Bedford's deer (*Cervus xanthopygus*) has unfortunately succumbed to a lingering decline, although happily not till it exhibited the remarkable variation between the summer and winter pélage. Roe deer, of course, flourish; and recently there was the opportunity of seeing the European, Siberian, and Manchurian species, or races, living side by side. The rare Chinese water-deer (*Hydropotes*) is represented by a single doe, which exhibits to perfection the skulking habits peculiar to the species; but a specimen of Michie's tufted deer, which formerly was one of the attractions of the collection, now adorns the museum at the Abbey. Musk-deer do not belie their hardy nature, and it is one of the most interesting sights in the park to watch these little deer bounding across their enclosure in the manner so well-known to all Himalayan sportsmen.

In marked contrast to the adaptability of the Oriental deer to their new surroundings is the ill-luck attending the introduction of most of the American deer, exclusive of the wapiti. The only exception to this is the Virginian deer, which flourishes and breeds, some mingling with the chital herd, others roaming at will in the open park, and a few taking up their abode in the immediate vicinity of the Abbey itself. These latter exhibit tameness and fearlessness to an extraordinary degree—only, indeed, exceeded by the members of a little herd of roe from the Caucasus, one of which permits itself to be fondled like a pet lamb. Black-tailed and, we believe, mule-deer have been tried without success; while the same ill-fate has attended several examples of the South American marsh deer and pampas deer. Young examples of each of these two latter are, however, at the present time in the collection, and as they are very carefully tended, and the experience derived from their predecessors is available, it may be hoped they will survive. A tiny little deer, apparently referable to *Mazama gymnotis*, is also among the newest arrivals, and its career will naturally be watched with deep anxiety. Brockets have been tried with hopeless ill-success, and the attempt to acclimatise them has reluctantly been abandoned.

During the very short period the collection has been in existence it has included, counting red and fallow deer, close on forty distinct species and races—no mean record when it is remembered that the total number of valid forms which have been exhibited in the London Zoological Gardens since its foundation does not exceed forty-eight. As every effort is being made to increase the Woburn collection, it bids fair to beat the record in the number of species, as it already does in individuals.

R. L.

Virginian. Chital. Mouflon. Chital. Black-Buck. Mouflon. Caspian Red Deer.

FIG. 2.—The Chital Paddock at Woburn Abbey, with Chital, Virginian Deer, Caspian Red Deer, Mouflon, and Black-Buck. (From a photograph by the Duchess of Bedford.)

THE LATE PROFESSOR A. SCHRAUF.

THE comparatively small number of mineralogical workers and teachers has been once more diminished, and to the recent deaths of Mallard, Daubrée, DesCloizeaux, Sohncke, Retgers, Kenngott, Haughton and Heddle, must now be added that of Albrecht Schrauf, Professor of Physical Mineralogy in the University of Vienna, who has passed away, after long illness, near the end of the sixtieth year of his age. A. Schrauf was born on December 14, 1837; he became assistant in the Mineral Department of the Imperial Museum of Vienna in 1861, and Keeper in 1867; after

1862 he added to his Museum duties the work of a "Docent" in the University; but eventually (1877) retired altogether from the Imperial Museum to take upon himself the duties of the University Professorship, involving the care of the University Mineral Collection: in this office he remained till the end of his life.

Much of Schrauf's published work consists in the technical examination and description of mineral species, but he also gave much thought to the general and recondite problems connected with atoms and molecules and their relation to the physical characters of crystals: his earlier speculations are incorporated in his "Treatise on Physical Mineralogy" published in 1866-68, but the later are only to be found in isolated memoirs. He was also the author of a useful handbook on "Precious Stones" (1869). Interested deeply in the philosophy of his subject, he sought the necessary mental and physical relaxation in the mechanics of crystal drawing, and undertook to prepare for publication an Atlas of the crystalline forms of all mineral species, taken in alphabetical order: but species and forms were discovered more quickly than figures could be prepared and sold, and the publication was discontinued before the letter D had been arrived at. The loss of a real thinker is a great one for any science.

NOTES.

Among those who have accepted nomination as vice-presidents of the general committee of the Fourth International Congress of Zoology are the following:—Prof. R. J. Anderson, of Belfast; Prof. Bridge, of Birmingham; Prof. D. J. Cunningham, of Dublin; Prof. Herdman, F.R.S., of Liverpool; Prof. M'Intosh, F.R.S., of St. Andrews; Mr. J. Cosmo Melvill, of Manchester; Prof. Lloyd Morgan, of Bristol; Prof. Alleyne Nicholson, F.R.S., of Aberdeen; Dr. Scharff, of Dublin; Dr. Traquair, F.R.S., of Edinburgh; Canon Tristram, F.R.S., of Durham; Lieutenant-Colonel R. G. Wardlaw Ramsay; and Prof. Percival Wright, of Dublin.

Mr. George Sharman retires at the end of this year from the post of Palæontologist to the Geological Survey of Great Britain. Entering the service just before the death of De la Beche in 1855, he served for a while under the first Director-General, and subsequently under Murchison, Ramsay, and Sir Archibald Geikie, with Mr. J. W. Salter and Mr. R. Etheridge as his senior colleagues. On the retirement of Mr. Etheridge in 1881, he was promoted, together with Mr. E. T. Newton, to take charge of the palæontological collections in the Museum of Practical Geology. Although he has published but little outside the "Memoirs of the Geological Survey," Mr. Sharman has sedulously devoted himself to the study of British fossils, and more especially the Invertebrata, his acquaintance with which is unequalled. The important aid which he has continuously given for over forty years to the field-geologists of the Survey is shown to some extent in the lists of fossils published in the official "Memoirs"; but no inconsiderable portion of his time has been given to those inquirers who so frequently come to a public museum with bags and pockets full of fossils to be identified by the officers. His skill and patience, and his readiness to give information have combined to characterise his long career as one of marked and unselfish devotion to the public service.

The death is announced of Prof. Wilhelm Joest, known by his travels in North Africa, America and Asia.

Mr. Henry Cecil, writing from Bournemouth, under date December 24, says:—"I was fortunate enough to see, at 1.13 this morning, in the middle of the latter half of its passage, the most remarkable meteor I ever saw. At that hour the sky was perfectly clear; and looking at the brilliant stars through the western of two windows looking south, I became suddenly aware of an intense white illumination overhead, which, from the steepness of the arc, could not, I think, have had its origin far to the westward of the zenith."

In the course of an article upon Sir W. E. Garstin's report on the work of the Irrigation Department of Egypt in 1896, the *Times* mentions as a new indication of scientific progress in Africa, that, since January 1, 1896, the water levels of the Victoria Nyanza have been daily recorded by means of gauges erected at three places, viz. Port Alice, Port Victoria, and Lubwas Usoga. The readings, as also a monthly statement showing the rise and fall of the lake, are received at Cairo; but the records of a series of years are necessary before any attempt can be made certainly to prognosticate the extent of influence that a rise or fall of the lake waters may produce on the Nile. The report states that gauges upon the Albert Nyanza are very urgently required in order to show what are the relations between the levels of that lake and the summer water supply in Egypt. This lake being nearer to the point of delivery, its levels are, if possible, more important to Egypt than are those of Lake Victoria, and the hope is expressed that the English officials at Uganda may erect gauges and furnish Egypt with records of the daily readings. Major R. H. Brown, Inspector-General of Irrigation for Lower Egypt, in his report for 1896 expresses the opinion that, as the catchment area of Lake Victoria is comparatively small, the lake may not have such an important influence on the Nile as we are accustomed to attribute to it, and that gauges at Fashoda, Khartum, and Berber are what is chiefly wanted.

We are glad to see that a Lincolnshire Science Society has been established. For many years there has been, in Lincolnshire, an absence of combination among scientific workers. Of individual investigators there is no lack, and much valuable work has been carried on by them; but from a want of knowledge of what has been, and what is being done by others in the special subjects in which each is interested, there has been a waste of time and energy. A central, organising, directive force has been wanting; and it is to supply this want, and to give to individuals and to the local county societies an opportunity for combining forces for the purpose of centralising and directing their efforts so that their various plans of action may be harmonised, that the Lincolnshire Science Society has been called into existence. The Society consists of a number of sections, the members of each of which devote themselves to the working out of one or more lines of research in the sciences that the sections represent. The presidents of the sections form the Council of the Society, and it is a part of their duty to suggest to the members and to the affiliated societies such lines of research and such methods as will be likely to yield the best results. The Society is at present actively helping on a scheme having for its object the foundation and the endowment of a county museum. The object is a worthy one, and we trust that both it and the Society will meet with the fullest encouragement and success. Particulars referring to the Society may be obtained from the president, Dr. G. M. Lowe, the hon. sec., Mr. G. Grierson, or the vice-president, Mr. J. H. Cooke, Thorndale, Lincoln.

A fresh contribution to our knowledge of the physiological effects of high altitudes is given by Prof. Piero Giacosa (*Rendiconti del R. Istituto Lombardo*, xvii.), who has studied more especially their influence on the exchange of material, and particularly on the elimination of nitrogen. Prof. Giacosa considers that as the altitude of 6000 metres is approached, there is an increasing risk of reaching the limit beyond which the physiological functions cannot be completed; but below 6000

metres the diminished pressure is never a direct and sufficient cause of the disorders that are observed, and its only effect is to aggravate those due to fatigue, to impaired digestion, and to other causes.

WRITING in the *Memorie della Società degli spettroscopisti Italiani*, xxvi., Dr. G. B. Rizzo publishes the details of a number of observations for determining the value of the solar constant. This value could not be determined with sufficient accuracy from experiments made at one station alone, as it was found that the results varied largely according to the formula employed; observations should therefore be taken at several stations differing considerably in altitude, but at no great horizontal distance apart. Four stations were therefore selected on Monte Rocciamelone, in the Val di Susa, at altitudes of 501, 1722, 2834 and 3537 metres, and by determining the intensity of solar radiation, referred to the zenith, at these stations, the relations between this intensity and the corresponding atmospheric pressure were expressed by means of two independent empiric formulæ. From these the author finally infers that the solar constant has a value of approximately 2·5 small calories per square centimetre per minute.

MR. R. F. ARNOTT writes to us from Sĕlángor, Straits Settlements, with reference to a note on the alleged conversion of Mexican silver dollars into gold, by Dr. Stephen H. Emmens (September 9, 1897, p. 451). He has assayed four Mexican dollars in circulation at Sĕlángor, and found gold in appreciable quantity, as follows:—

Number of assay.	Marks.	Gold.
1. ...	8 R.G.^A 1874 I.G.	... 0·06 per cent.
2. ...	8 R.O.^A 1892 E.N.	... 0·09 ,,
3. ...	8 R.G.^A 1893 J.S.	... 0·08 ,,
4. ...	8 R.G.^A 1895 M.M.	... 0·01 ,,

The dollars were taken at random from rather more than a hundred different issues, and no unusual treatment was employed during assay. The results are worth putting on record, as they suggest a possible origin of the gold in the "argentaurum" manufactured by Dr. Emmens. It is, however, well known that gold exists in Mexican dollars. Our attention has been called to the fact that in 1891 an examination of 11,846 such coins was made at the Royal Mint (see Report of the Deputy-Master of the Mint for 1891, pp. 110–113). The dollars from all the Mexican mints were found to contain gold, the average amount being 0·309 per 1000. Those from Guadalajara (Nos. 1, 3 and 4 of Mr. Arnott) numbered 463, and contained an average of 0·964 of gold per 1000. In connection with the presence of gold in silver, Mr. Arnott points out that much of the silver received at the Indian mints some years ago was rich in gold; sycee containing an average of about 0·9 per cent., and silver coins issued contained as much as 0·09 per cent. of gold.

THE attention of the commercial interests of Germany has recently been directed to the great advantage that would be derived to the trade of that country by the completion of the canal system joining the Black Sea with the North Sea, and also with the Baltic. At present all merchandise conveyed to and from the East has to go round by sea to Hamburg or Stettin, the distance by sea being more than 3000 miles as compared with about 1000 miles through Austria and Germany by a system of inland waterways. Two Congresses have recently been held —one at Passau, in Bavaria, and the other at Vienna—for the study and discussion of schemes for developing this through communication, and the Ministry of Commerce at Vienna has had inquiries made as to the feasibility of the plans proposed. These are to open out and improve the Ludwig Canal, which connects the Danube with the Main, and so with the Rhine, so as to make it available for barges carrying 500 tons, and thus completing a direct water-way between the Black and North Seas. The length of this canal is 106 miles, and it now has a depth of water of only five feet and a navigation fitted for 127-ton barges. The second part of the proposed scheme is to connect the Danube with the Elbe by a new canal from the former, near Vienna, turning in a north-west direction to join the Upper Moldau, and by the canalisation of this river to Prague, and of the Elbe to Aussen. The third scheme is to connect the Austrian and German water-ways by connecting the March, an effluent of the Danube, with the Oder, and making the system capable of taking 600-ton barges, and thus connecting the Black Sea with the Baltic. The Russian scheme, having a similar object, and described in NATURE of February 25, is to be commenced forthwith.

THE latest issue of the *Memoirs* of the Caucasian branch of the Russian Geographical Society (vol. xvii. part 1), contains the first part of a very valuable work, by A. V. Voznesensky, on the precipitation in Caucasia. The author gives first a series of tables, for 113 Caucasian stations, showing the amounts of rain and snow, and the numbers of days with rain or snow, for every month of every year during which observations were made at each station. The position of each observatory—its latitude, longitude and altitude, the elevation of the pluviometer above the ground, and general remarks are also given; and at the end of the work the results are summed up in a general table. Sixteen maps accompany the work: one of them is an orographical map of Caucasia; then come two series, of five maps each, showing by curves the geographical distribution of precipitation over the territory, *i.e.* the average amount of precipitation, and the probability of snow or rain for the whole year and for each season separately. The distribution of precipitation during the different months of the year is next represented by diagrams for thirty stations; and seven different types having thus been established, the geographical distribution of the regions belonging to each of these types is given on a map. Another map shows the more or less uniformity which exists in the distribution of precipitation during the year in various parts of Caucasia; and two more maps represent by curves the regions of summer and winter droughts, as well as the intermediate regions. The text in which the general conclusions had to be discussed has been left for a second part of the same work, the author having had to leave the Caucasus to take up the management of a meteorological station at Irkutsk.

It is thirty-five years since the late Mr. S. P. Woodward described the remarkable fossil *Barrettia* from the Cretaceous limestone of Jamaica. Though in general appearance it resembled an operculate coral, Mr. Woodward came to the conclusion that it was really an aberrant Lamellibranch of the Hippurite group. Since that time nothing has been added to our knowledge of the form; but in a recent *Bulletin* of the American Museum of Natural History, Mr. R. P. Whitfield gives the results of his study of a large series of specimens obtained from the original locality, which show certain additional details of structure. He cannot agree that *Barrettia* was a Lamellibranch, but strongly inclines to place it among the corals: it certainly is a very isolated form, as the only corals with which he is able to suggest comparisons in structure are of Palæozoic age.

"Do the crystalline gneisses represent portions of the original earth's crust?" is the question asked, and answered in the affirmative, by Mr. J. Lomas, in his recent presidential address to the Liverpool Geological Society (published in the December *Geological Magazine*). Excluding gneisses of later igneous or metamorphic origin, there remain the great series of fundamental gneisses, world-wide in distribution and uniform in general character, which must have had some world-wide cause of

origin. As a possible cause of their foliation, Mr. Lomas suggests tidal action in the incompletely-consolidated crust. Prof. G. H. Darwin has shown that huge tidal wrinkles must have been raised by the moon when near the earth, forming idges and troughs which ran north and south near the Equator, and curved to the eastward as they approached the Poles. The strike of the gneisses of Britain and Scandinavia corresponds to the direction of these tidal wrinkles in those latitudes, and there is evidence that the Palæozoic strata were deposited in troughs parallel to the gneissic ridges. In Anglesey, according to Mr. Lomas, we have a portion of one such ridge that may never have been submerged under the sea.

THE Cambridge University Press has just published a volume of "Solutions of the Exercises in Taylor's Euclid" (Pitt Press Mathematical Series), Books VI.-XI.

MR. H. TRIMBLE reprints, from the *American Journal of Pharmacy*, a series of papers by himself and the late Prof. E. S. Bastin, on "Some North American Coniferæ." Some of the more important American species from an economical point of view are described in detail, special attention being given to the microscopical structure of the leaf and stem and to the chemical composition of the wood. Excellent photographs are given to show the habit of each species, and woodcuts of microscopic sections.

A SECOND edition of Mr. Arthur Mee's "Observational Astronomy," greatly enlarged and improved, has just been published by the office of the *Western Mail*, Cardiff. The new edition is, in point of illustration, vastly superior to the original work, some of the half-tone blocks being very fine reproductions; the text also has been through the refining fire. The volume should be in the possession of every amateur astronomer, however limited his instrumental equipment may be; for it will bring him right into the current of astronomical thought, and inspire him to make the best use of his opportunities.

VOL. VIII., part 1, of the *Proceedings* of the Liverpool Geological Society contains a valuable series of papers. These include the presidential address on "Glacial Geology," and a paper on "Ayrshire Geology," by Mr. Mellard Reade; detailed and illustrated accounts of the "Carboniferous Limestone of the Clwyd Valley," by Mr. G. H. Morton; of the "Igneous Rocks of Aran Mowddwy," by Mr. T. H. Cope; and of the "Varanger Fjord," by Messrs. Dickson and Holland. Mr. Lomas investigates the earthquake of December 17, 1896, and traces the isoseismal lines; and Dr. Callaway criticises the chemical evidence for the existence of organisms in Archæan times, finding it quite fallacious.

THE Thornton-Pickard Manufacturing Company, Ltd., have sent us a copy of their new illustrated catalogue for 1898. Several very fine half-tone reproductions of photographs illustrate the catalogue, and testify to the excellence of results obtained with cameras and instantaneous shutters manufactured by the firm. Among the apparatus which call for special mention are a new 5 × 4 size of the Amber camera, a new patent film carrier, and a new aluminium shutter. The firm offers 200*l.* in prizes for the best results obtained with their cameras and shutters. Full particulars of this competition, as well as many serviceable hints to photographers, will be found in the catalogue, a copy of which will be forwarded on application.

WE have received the yearly report of the Russian Geographical Society for the year 1896, and it is full of interest. It contains, as usual, the obituaries of the members whom the Society lost during the year, condensed reports of the expeditions of the Society, a review of its publications, and excellent accounts of the work done by those geographers to whom medals were awarded by the Society in 1896. Very valuable feature of this year's reports are the yearly reports of the Siberian branch of the Society (Irkutsk) and of the Amur branch (Khabarovsk) for the years 1894 and 1895, as also of the Society for the Study of the Amur Region for the year 1895. Unfortunately, one does not find in the report any information concerning the extremely interesting but almost quite unknown activity of the West Siberian branch of the Russian Geographical Society.

A SECOND edition of Prof. J. J. Thomson's "Elements of the Mathematical Theory of Electricity and Magnetism" has just been published by the Cambridge University Press. The first edition, published in 1895, was reviewed in NATURE (vol. liv. p. 97), and as few alterations have been made, we need do no more than announce the appearance of the new edition, and express pleasure that the work is finding its way into the hands of an increasing number of students.—Prof. J. A. Ewing's work on "The Steam Engine and other Heat Engines" (Cambridge University Press), reviewed in NATURE three years ago (vol. li. p. 219), has also reached a second edition. A considerable amount of new matter has been added to the volume, and the section relating to gas engines has been much extended. To the thoughtful student of engineering science the book is invaluable. —Part 2 of "An Illustrated Manual of British Birds," by Mr. Howard Saunders, has been published by Messrs. Gurney and Jackson. The work will be completed in twenty parts, and will contain illustrations of nearly every species.

THE annual report on the work of the Institute of Jamaica has been received. The Science Section of the Institute appears to have been particularly active in the period covered by the report. A number of changes have been made in the systematic arrangement of the objects in the museum. In the zoological collection a 4 to 6 per cent. solution of formalin has been mostly employed as a preservative fluid and found to work very satisfactorily, though the colours of the objects were not retained for long in specimens exposed to strong light. For delicate objects, such as jellyfish and sea-anemones, it is found to be extremely serviceable, preserving perfectly the natural form and histology. Research work, mainly upon the Actinaria of the island, has been continued in the Biological Laboratory of the Institute. A paper on the Jamaica Zoanthidæ, embracing a description of ten species, has been prepared by the curator for publication; also one on the Actinian family Aliciidæ, describing, amongst others, a new Jamaica species of Bunodeopsis. During the summer months three students from the Johns Hopkins University, under the direction of Prof. Brooks, established a temporary marine laboratory at Port Henderson. Contributions to Jamaican zoology have been made by them, and many specimens were presented to the museum. Investigations of Indian remains have been continued from last year, and more valuable material collected from the caves and refuse-heaps. The objects, however, do not differ greatly in type from those referred to in the last report. An account of the results, illustrated with numerous figures, plates, and a map, will shortly be published in the *Journal* of the Institute. The report thus shows that the Institute is actively assisting in the advancement of knowledge, as well as working in various ways to create and stimulate interest in scientific objects and study.

IN the current number of the *Berichte*, P. Walden describes the very remarkable effect produced by the addition of a uranyl salt to a solution of an optically active substance. When a substance such as *l*-malic acid is dissolved in water along with one molecule of uranyl nitrate and about four molecules of caustic potash, the rotation produced by the solution is more than five hundred times as great as that of the acid alone, whilst it remains of the same sign. Similar, but less intense effects are

observed with other optically active hydroxy-acids and their ethereal salts, but no increase is produced with optically active substances, such as chlorosuccinic acid, which do not contain a hydroxyl group, and indeed a slight diminution is caused in some of these cases. Optically inactive acids, such as mesotartaric acid, inactive malic acid, &c., are quite unaffected by the addition of these substances. Apart from its high theoretical interest, the phenomenon provides a ready method of distinguishing active substances of low rotatory power from their inactive isomerides.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂), a Black-backed Jackal (*Canis mesomelas*, ♀) from South Africa, presented by Major Haynes Sadler; a Red-bellied Wallaby (*Macropus billardieri*) from Tasmania, presented by Mrs. Beaumont; a Guillemot (*Lomvia troile*), British, presented by Mr. John Pettitt; a Yellow-cheeked Lemur (*Lemur xanthomystax*) from Madagascar, a Marsh Harrier (*Circus æruginosus*), European, deposited; six Summer Ducks (*Æx sponsa*, 5 ♂, 1 ♀), purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JANUARY:—

January	h. m. h. m.	
2.		Meteoric shower from Quadrans (230° + 52°).
3.	6 59 to 8 16.	Occultation of 16 Tauri (mag. 6·5).
3.	7 13 ,, 8 27.	,, 17 ,, 3·8).
3.	8 2 ,, 9 11.	,, 23 ,, 4·2).
3.	8 46 ,, 10 8.	,, η ,, 3·0).
3.	9 55 ,, 11 11.	,, 28 ,, 6·2).
3.	10 1 ,, 10 59.	,, 27 ,, 3·8).
5.		Uranus 52′ S. of β Scorpii.
5.	12 56 to 13 58.	Occultation of 125 ,, 4·9)
7.	10 57 ,, 12 32.	Partial eclipse of the moon. Magnitude 0·157 at 11h. 45m.
9.	8 11 ,, 9 8.	Occultation of o' Cancri (mag. 5·2).
10.	15 53 ,, 17 4.	Occultation of B.A.C. 3398 (mag. 6·0).
14.	5	Jupiter in conjunction with moon. ♃ 7° 5′ N.
17.	16 30 to 17 31.	Occultation of B.A.C. 5314 (mag. 5.4).
17.	18 51 ,, 20 1.	,, ,, 5347 ,, 5·8).
18.	7	Saturn in conjunction with moon. ♄ 5° 40′ N.
18.	12 53 to 15 25.	Transit of Jupiter's Satellite III.
20.	8 31.	Minimum of β Persei (Algol).
21.		Total eclipse of the sun invisible at Greenwich. Begins on the earth generally 16h. 46m., ends 21h. 53m.
23.	5 20.	Minimum of β Persei (Algol).
25.	11 56 to 14 52.	Transit of shadow Jupiter's Sat. III.
25.	16 37 ,, 19 6.	,, Jupiter's Sat. III.
29.	4.	Mercury at greatest elongation (25° 4′ W.)

"NAUTICAL ALMANAC" CORRIGENDA.—In a letter to the *Journal* of the British Astronomical Association, Dr. A. M. W. Downing forcibly impresses upon astronomers the necessity and importance of consulting the page of *errata* in each issue of the *Nautical Almanac*. In consequence of the *Nautical Almanac* going to press four years in advance, any corrections to data influencing the tables gives, of course, slightly modified results. We read, for instance, that "in the first edition of the *Nautical Almanac* for 1898 (issued in December 1894) the data are affected by an error which throws out the times of the lunar eclipses to a considerable extent; in the second edition (issued last April), and in a subsequent edition, now being struck off, this error has been corrected. The correct data are also given amongst the *errata* on page xiii of the *Nautical Almanac* 1899. It will therefore be advisable for those interested in these phenomena, should they happen to possess the first edition of the *Nautical Almanac* for 1898, to correct the data for lunar eclipses in that edition by the *errata* given in the *Nautical Almanac* for 1899."

Another correction in the same edition is the position of 16 Tauri in the Pleiades, which makes an occultation of this star on January 3 a near approach only.

OCCULTATION OF THE PLEIADES.—For the third time in less than half a year the Pleiades will suffer occultation by the moon on January 3. As in the case of the occultation which took place last October, all the brighter stars will be occulted with the exception of 16 Tauri (see note on "*Nautical Almanac* Corrigenda"), and this star, although approaching very near, is just missed. The most interesting occultation will be that of Alcyone (mag. 3·0), the brightest star in the Pleiades, and its disappearance at the dark limb should be seen with the smallest telescope. The times are as follow:—

Time of disappearance, January 3d. 8h. 46m. G.M.T.
,, reappearance ,, 10h. 8m. ,,

The Iris Gulf will be in the neighbourhood of the terminator where the star disappears.

The passage of the moon before the Pleiades, although a beautiful phenomenon at any time, in this case loses some of its charm through the brightness of the moon, her age being nearly 11 days, and consequently the aërial reflection will overpower the fainter stars of this group.

PARTIAL ECLIPSE OF THE MOON.—That the moon is getting into position for eclipsing the sun on January 22 is announced by the fact that she herself is under partial eclipse at the preceding lunation on January 7. The phenomenon commences a little before midnight, and ends an hour and a half after.

The eclipse is a very small one, its magnitude being only 0·157 (moon's diameter = 1).

The following are the corrected phases as given in the *Nautical Almanac* (1898) (see note on "*Nautical Almanac* Corrigenda.")

		d.	h. m.	
First contact with the penumbra,	January	7	10 1·2	p.m.
,, ,, ,, shadow	,,		11 47·4	,,
Middle of eclipse	,,	8	0 34·9	a.m.
Last contact with the shadow	,,		1 22·4	,,
,, ,, ,, penumbra	,,		3 8·6	,,

NEW INVESTIGATIONS OF β LYRÆ.—Prof. A. Belopolsky has recently completed a new series of photographs in connection with the spectrum variations of β Lyræ; and his paper on "New investigations of the spectrum of β Lyræ" appears in the *Astrophysical Journal*, November 1897. In all, twenty-six photographs have been taken corresponding to all the phases of brightness, and the results are especially interesting since an "iron comparison" has enabled him to determine the velocity of the system with respect to the sun, and also the radial velocities at different parts of the orbit.

The dark line at λ 4482 has been utilised in making all the measures, for this line changes but little in appearance, whilst the lines λ 4471, H_β and H_γ undergo great variations.

From measures made of the above line, with the iron comparison as datum lines, he finds that the proper motion of the system = −2·00 geographical miles, and the maximum radial velocity is about 25 geographical miles. Moreover, the curve of radial velocities shows that the changes of brightness may be sufficiently well explained by an *eclipse*; for the times of radial velocity = 0 are very close to the times of principal and secondary minima. His description of the cyclical changes which take place in the appearances of the lines at $\lambda\lambda$ 4471 and 4482, and the reappearance of certain additional lines at particular phases agrees remarkably well with the Kensington results, which, it may be remembered, showed that of the components producing the dark lines, one was like Bellatrix, and the other gave a spectrum similar to that of Rigel.

THE ATMOSPHERES OF PLANETS.—Dr. Johnstone Stoney's name has long been connected with an important theorem in molecular physics, which may be thus stated. The atmosphere round any planet will extend to a height determined by the force of gravity on that planet, and if the speed with which the molecules move in that atmosphere exceed a critical velocity, they will escape from the planet and move independently in space. In the *Transactions* of the Royal Dublin Society, November 1897, Dr. Stoney has given in some detail his full views on this subject, and substituted better numerical results for those originally given in scattered scientific papers, by basing them on the fact that helium, whose density is twice that of hydrogen, can, and does, escape from the earth. It is contended that helium is continually being supplied to the earth's atmosphere from hot springs, that it exhibits no tendency to combine with other elements, and since no trace of it can be found in the atmosphere, it escapes above, as rapidly as it enters below. Water vapour, on the other hand, remains on the earth, and consequently limits of speed can be assigned between which

gases are either imprisoned or are free to escape. For the earth, under favourable circumstances, a velocity of 10·5 km. per sec. would be sufficient to carry a molecule beyond gravitational control, and this is 6·5 times the "velocity of mean square" in hydrogen gas at a temperature of – 66° C.; 9·27 times that of helium at the same temperature, and 19·66 times that of water vapour. Since the two former gases escape and the latter does not, it would seem that the velocity attained by molecules can exceed nine times the average velocity, but cannot reach that of twenty. Assuming that Venus retains a moisture-laden atmosphere, about which Dr. Stoney seems very positive, this latter number can be reduced to eighteen, and thus still closer express the actual velocity in terms of that of the "mean square."

Limiting the inquiry to a temperature of – 66° C., Dr. Stoney applies the theory to all members of the solar system with the following results. From the moon all gases having a vapour density less than 39 will escape with greater promptness than helium does from the earth. On Mercury, water cannot exist, while nitrogen and oxygen would gradually dribble away. The conditions on Venus resemble those on the earth, but the case of Mars is of exceptional interest. Dr. Stoney says that it is legitimate to infer that on this planet water cannot remain. The atmosphere he considers to consist mainly of nitrogen, argon, and carbon dioxide. He thinks there is no vegetation, as we understand the term, on the surface of the planet, and the snow, frost, and fog do not arise from the same cause as on the earth. Jupiter is able to imprison all gases known to chemists, but whether the more distant members of our system can retain hydrogen is doubtful. Helium and the denser gases probably float in their atmospheres, but the molecules of the lighter gases are describing orbits about the sun, the velocity they can acquire enabling them to escape from planetary control, but still insufficient to liberate them from the gravitational influence of the sun.

THE DENSITIES OF CERTAIN GASES.[1]

THE observations here recorded were carried out by the method and with the apparatus described in a former paper,[2] to which reference may be made for details. It must suffice to say that the globe containing the gas to be weighed was filled at 0° C., and to a pressure determined by a manometric gauge. This pressure, nearly atmospheric, is slightly variable with temperature on account of the expansion of the mercury and iron involved. The actually observed weights are corrected so as to correspond with a temperature of 15° C. of the gauge, as well as for the errors in the platinum and brass weights employed. In the present, as well as in the former, experiments I have been ably assisted by Mr. George Gordon.

Carbonic Oxide.

This gas was prepared by three methods. In the first method a flask, sealed to the rest of the apparatus, was charged with 80 grams recrystallised ferrocyanide of potassium and 360 c.c. strong sulphuric acid. The generation of gas could be started by the application of heat, and with care it could be checked and finally stopped by the removal of the flame with subsequent application, if necessary, of wet cotton wool to the exterior of the flask. In this way one charge could be utilised with great advantage for several fillings. On leaving the flask the gas was passed through a bubble containing potash solution (convenient as allowing the rate of production to be more easily estimated), and thence through tubes charged with fragments of potash and phosphoric anhydride, all connected by sealing. When possible, the weight of the globe *full* was compared with the mean of the preceding and following weights *empty*. Four experiments were made with results agreeing to within a few tenths of a milligram.

In the second set of experiments the flask was charged with 100 grams of oxalic acid and 500 c.c. strong sulphuric acid. To absorb the large quantity of CO_2 simultaneously evolved a plentiful supply of alkali was required. A wash-bottle and a long nearly horizontal tube contained strong alkaline solution, and these were followed by the tubes containing solid potash and phosphoric anhydride as before.

For the experiments of the third set *oxalic* acid was replaced by *formic*, which is more convenient as not entailing the absorption of large volumes of CO_2. In this case the charge consisted of 50 grams formate of soda, 300 c.c. strong sulphuric acid, and 150 c.c. distilled water. The water is necessary in order to prevent action in the cold, and the amount requires to be somewhat carefully adjusted. As purifiers, the long horizontal bubbler was retained and the tubes charged with solid potash and phosphoric anhydride. In this set there were four concordant experiments. The immediate results stand thus:—

Carbonic Oxide.

From ferrocyanide	2·29843
,, oxalic acid	2·29852
,, formate of soda	2·29854
Mean...	2·29850

This corresponds to the number 2·62704 for oxygen (*loc. cit.*, p. 144), and is subject to a correction (additive) of 0·00056 for the diminution of the external volume of the globe when exhausted.

The ratio of the densities of carbonic oxide and oxygen is thus 2·29906 : 2·62760; so that if the density of oxygen be taken as 32, that of carbonic oxide will be 27·9989. If, as some preliminary experiments by Dr. Scott (*Camb. Phil. Proc.*, vol. ix. p. 144, 1896) indicate, equal volumes may be taken as accurately representative of CO and of O_2, the atomic weight of carbon will be 11·9989 on the scale of oxygen = 16.

The very close agreement between the weights of carbonic oxide prepared in three different ways is some guarantee against the presence of an impurity of widely differing density. On the other hand, some careful experiments led Mr. T. W. Richards (*Amer. Acad. Proc.*, vol. xviii. p. 279, 1891) to the conclusion that carbonic oxide is liable to contain considerable quantities of hydrogen or of hydrocarbons. From 5½ litres of carbonic oxide passed over hot cupric oxide he collected no less than 25 milligrams of water, and the evidence appeared to prove that the hydrogen was really derived from the carbonic oxide. Such a proportion of hydrogen would entail a deficiency in the weight of the globe of about 11 milligrams, and seems improbable in view of the good agreement of the numbers recorded. The presence of so much hydrogen in carbonic oxide is also difficult to reconcile with the well-known experiments of Prof. Dixon, who found that prolonged treatment with phosphoric anhydride was required in order to render the mixture of carbonic oxide and oxygen inexplosive. In the presence of relatively large quantities of free hydrogen (or hydrocarbons) why should traces of water vapour be so important?

In an experiment by Dr. Scott (*Chem. Soc. Trans.*, 1897, p. 564), 4 litres of carbon monoxide gave only 1·3 milligrams to the drying tube after oxidation.

I have myself made several trials of the same sort with gas prepared from formate of soda exactly as for weighing. The results were not so concordant as I had hoped,[1] but the amount of water collected was even less than that given by Dr. Scott. Indeed, I do not regard as proved the presence of hydrogen at all in the gas that I have employed.[2]

Carbonic Anhydride.

This gas was prepared from hydrochloric acid and marble, and after passing a bubbler charged with a solution of carbonate of soda, was dried by phosphoric anhydride. Previous to use, the acid was caused to boil for some time by the passage of hydrochloric acid vapour from a flask containing another charge of the acid. In a second set of experiments the marble was replaced by a solution of carbonate of soda. There is no appreciable difference between the results obtained in the two ways; and the mean, corrected for the errors of weights and for the shrinkage of the globe when exhausted, is 3·6349, corresponding to 2·6276 for oxygen. The temperature at which the globe was charged was 0° C., and the actual pressure that of the manometric gauge at about 20°, reduction being made to 15° by the use of Boyle's law. From the former paper it appears that the actual height of the mercury column at 15° is 762·511 mm.

1 "On the Densities of Carbonic Oxide, Carbonic Anhydride, and Nitrous Oxide." By Lord Rayleigh, F.R.S. (Read at the Royal Society, December 9, 1897.)

2 "On the Densities of the Principal Gases," *Roy. Soc. Proc.*, vol. liii. p. 134, 1893.

1 One obstacle was the difficulty of re-oxidising the copper reduced by carbonic oxide. I have never encountered this difficulty after reduction by hydrogen.

2 In Mr. Richards' work the gas in an imperfectly dried condition was treated with hot platinum black. Is it possible that the hydrogen was introduced at this stage?

Nitrous Oxide.

In preliminary experiments the gas was prepared in the laboratory, at as low a temperature as possible, from nitrate of ammonia, or was drawn from the iron bottles in which it is commercially supplied. The purification was by passage over potash and phosphoric anhydride. Unless special precautions are taken the gas so obtained is ten or more milligrams too light, presumably from admixture with nitrogen. In the case of the commercial supply, a better result is obtained by placing the bottles in an inverted position so as to draw from the *liquid* rather than from the *gaseous* portion.

Higher and more consistent results were arrived at from gas which had been specially treated. In consequence of the high relative solubility of nitrous oxide in water, the gas held in solution after prolonged agitation of the liquid with impure gas from any supply, will contain a much diminished proportion of nitrogen. To carry out this method on the scale required, a large (11-litre) flask was mounted on an apparatus in connection with the lathe so that it could be vigorously shaken. After the dissolved air had been sufficiently expelled by preliminary passage of N_2O, the water was cooled to near 0° C. and violently shaken for a considerable time while the gas was passing in large excess. The nitrous oxide thus purified was expelled from solution by heat, and was used to fill the globe in the usual manner.

For comparison with the results so obtained, gas purified in another manner was also examined. A small iron bottle, fully charged with the commercial material, was cooled in salt and ice and allowed somewhat suddenly to blow off half its contents. The residue drawn from the bottle in one or other position was employed for the weighings.

Nitrous Oxide (1896).

Aug. 15	Expelled from water	...	3·6359
,, 17	...	...	3·6354
,, 19	From residue after blow off,	valve downwards	3·6364
,, 21	,, ,,	valve upwards ...	3·6358
,, 22	,, ,,	valve downwards	3·6360
	Mean	...	3·6359

The mean value may be taken to represent the corrected weight of the gas which fills the globe at 0° C. and at the pressure of the gauge (at 15°), corresponding to 2·6276 for oxygen.

One of the objects which I had in view in determining the density of nitrous oxide was to obtain, if it were possible, evidence as to the atomic weight of nitrogen. It may be remembered that observations upon the density of pure nitrogen, as distinguished from the atmospheric mixture containing argon which, until recently, had been confounded with pure nitrogen, led [1] to the conclusion that the densities of oxygen and nitrogen were as 16 : 14·003, thus suggesting that the atomic weight of nitrogen might really be 14 in place of 14·05, as generally received. The chemical evidence upon which the latter number rests is very indirect, and it appeared that a direct comparison of the weight of nitrous oxide and of its contained nitrogen might be of value. A suitable vessel would be filled, under known conditions, with the nitrous oxide, which would then be submitted to the action of a spiral of copper or iron wire rendered incandescent by an electric current. When all the oxygen was removed, the residual nitrogen would be measured, from which the ratio of equivalents could readily be deduced. The fact that the residual nitrogen would possess nearly the same volume as the nitrous oxide from which it was derived would present certain experimental advantages. If, indeed, the atomic weights were really as 14 : 16, the ratio (x) of volumes, after and before operations, would be given by

$$\frac{2·2996 \times x}{3·6359 - 2·2996 \times x} = \frac{14}{8},$$

whence

$$x = \frac{7 \times 3·6359}{11 \times 2·2996} = 1·0061,$$

3·6359 and 2·2996 being the relative weights of nitrous oxide and of nitrogen which (at 0° C. and at the pressure of the gauge) occupy the same volume. The integral numbers for the atomic weights would thus correspond to an expansion, after chemical reduction, of about one-half per cent.

But in practical operation the method lost most of its apparent simplicity. It was found that copper became unmanageable at a temperature sufficiently high for the purpose, and recourse was had to iron. Coils of iron suitably prepared and supported could be adequately heated by the current from a dynamo without twisting hopelessly out of shape; but the use of iron leads to fresh difficulties. The emission of carbonic oxide from the iron heated in vacuum continues for a very long time, and the attempt to get rid of this gas by preliminary treatment had to be abandoned. By final addition of a small quantity of oxygen (obtained by heating some permanganate of potash sealed up in one of the leading tubes) the CO could be oxidised to CO_2, and thus, along with any H_2O, be absorbed by a lump of potash placed beforehand in the working vessel. To get rid of superfluous oxygen, a coil of incandescent copper had then to be invoked, and thus the apparatus became rather complicated.

It is believed that the difficulties thus far mentioned were overcome, but nevertheless a satisfactory concordance in the final numbers was not attained. In the present position of the question no results are of value which do not discriminate with certainty between 14·05 and 14·00. The obstacle appeared to lie in a tendency of the nitrogen to pass to higher degrees of oxidation. On more than one occasion, mercury (which formed the movable boundary of an overflow chamber) was observed to be attacked. Under these circumstances I do not think it worth while to enter into further detail regarding the experiments in question.

The following summary gives the densities of the various gases relatively to air, all obtained by the same apparatus.[1] The last figure is of little significance.

Air free from H_2O and CO_2	1·00000
Oxygen	1·10535
Nitrogen and argon (atmospheric) ...	0·97209
Nitrogen	0·96737
Argon	1·37752
Carbonic oxide	0·96716
Carbonic anhydride	1·52909
Nitrous oxide	1·52951

The value obtained for hydrogen upon the same scale was 0·06960; but the researches of M. Leduc and of Prof. Morley appear to show that this number is a little too high.

THE NORTHAM PEBBLE RIDGE.

THE pebble ridge at Northam is one of the most remarkable examples of littoral drift to be found anywhere round the coast of this country.

It is thus graphically described by Charles Kingsley in "Westward Ho!":—"On this pebble ridge the surges of the bay have defeated their own fury by rolling up in the course of ages a rampart of grey boulder stones, some two miles long, as cunningly curved and smoothed and fitted as if the work had been done by human hands, which protect from the high tides of spring and autumn a fertile sheet of smooth alluvial turf. . . . It was dead calm and yet the air was full of sound—a low deep roar which hovered over downs and broad, salt marsh and river, like the roll of a thousand wheels, the tramp of endless armies, or—what it was—the thunder of a mighty surge upon the boulders of the pebble ridge. . . . The spirit of the Atlantic storm had sent forward the token of his coming in the smooth ground swell which was heard inland two miles away. To-morrow the pebbles, which were now rattling down with each retreating wave, might be leaping to the ridge top and hurled like round shot far ashore upon the marsh by the force of the advancing wave fleeing before the wrath of the western hurricane."

The particulars contained in the following description of this ridge have been obtained during a recent inspection of this part of the coast of North Devon, and from information obtained from the coastguard and others living in the locality.

The boulders which compose the ridge have been derived from the cliffs which surmount the shore of Barnstaple Bay, from Hartland Point to Westward Ho, a distance along the coast of about thirteen miles. These cliffs rise to a height of 350 feet above the level of the sea between Hartland Point and Clovelly, the height then gradually diminishing towards Westward Ho, where they terminate. They are composed principally

[1] Rayleigh and Ramsay, *Phil. Trans.*, vol. clxxxvi. p. 190, 1895.

[1] *Roy. Soc. Proc.*, vol. liii. p. 148, 1893; vol. lv. p. 340, 1894; *Phil. Trans.*, vol. clxxxvi. p. 189, 1895; *Roy. Soc. Proc.*, vol. lix. p. 201, 1896.

of hard carboniferous grit of a dark slate colour, except at the western end, where this rock is interspersed with red sandstone and shale and a few pockets of glacial drift. The beach between the foot of the cliffs and low water consists of rocks cut and furrowed by the action of the sea in perpetually rolling about the large boulders which lie along its surface.

Beyond Westward Ho the estuary of the Taw and the Torridge commences, consisting of a vast expanse of sand bounded by sand dunes.

Large fragments of rocks have in the course of ages been dislodged from the cliffs, the remains of which perpetually rolled about by the waves of the sea during high tides, which here rise to a height of 27 feet, have acted as instruments for grinding their fellows, and battering the cliffs, and so producing the rounded boulders which now strew the beach throughout its whole length for several miles, and a portion of which, drifted along the shore of the bay, have become finally heaped up in the Northam pebble ridge.

In some parts of the cliff indents of considerable size have been cut out, and across these the boulders have collected, and been thrown up into ridges and banks. At Abbotsham, about twelve miles from Hartland, there is such a bank, the top of which is 9 feet above high water of spring tides. This ridge or bank is about 160 feet wide, the boulders of which it is composed varying in size at the top from about 12 inches in length by 4 inches in diameter to pebbles 3 inches in diameter, the largest boulders weighing about 12 lbs., those at the foot reaching to a length of 2 feet and weighing about 70 lbs. Notwithstanding the large size of the boulders of which the bank is composed its sea face is shaped into a ridge and hollow, similar to other pebble ridges, the position of which varies according to the height of previous spring tides. The pebbles left on the shelf or hollow at the spring-tide level average a smaller size than those at the other part of the bank.

The boulders scattered along the beach all lie above the level of low water of neap tides. The general direction of movement is eastwards, but the boulders follow the line of the coast and the set of the flood tide. This direction varies round the bay from eastward to south-east, east again and then north-east, and finally south-east. The direction of the wind which drives the heaviest sea into the bay is from the north-west.

The Northam pebble ridge commences at the termination of the cliffs, and runs in a north north-easterly direction for upwards of two miles across a low flat plain which is below the level of high tides, until it falls into some hummocks of blown sand. It thus forms a natural embankment enclosing a tract of 900 acres of sandy and alluvial grass land which is used for grazing purposes, and also as golf links. After running along the foot of the sand hills for a short distance the pebble bank turns sharply to the south-east up the course of the outfall of the two rivers, the boulders diminishing in size to pebbles and coarse sand. There is an outlying bed of boulders, known as the Pulley, situated some distance from the bank, on the edge of the low-water channel of the river, but these appear to be a fixed deposit which neither increases nor diminishes in size.

The ridge is approximately 180 feet wide at the base and 20 feet high, the top being about 25 to 30 feet wide and 6 feet above high water of spring tides. The boulders on the top of the bank vary in size from about 12 inches in length by 6 inches in diameter to pebbles an inch in diameter, the average size being about 8 inches in length by 4 inches in diameter, the largest being about 12 inches long and weighing from 40 to 50 lbs. At the foot of the bank are to be found boulders measuring from 15 to 18 inches in length and weighing from 100 to 150 lbs. The size of the boulders does not vary much throughout the length of the bank. The greatest collection of small stones appears to be on the shelf or hollow at the level of spring tides, where the pebbles vary from about half an inch to four inches in diameter. Some of the larger boulders have been drifted quite to the far end of the bank.

The boulders consist entirely of the same description of slate-coloured carboniferous grit as the cliffs from Hartland to Abbotsham are composed of, and there can be no doubt that they have drifted from this part of the coast. At the commencement of the ridge there are fairly numerous samples of shale and red sandstone pebbles from the cliffs between Westward Ho and Abbotsham, but these gradually disappear further along the ridge, the softer rock of which they are composed evidently not being able to withstand the constant grinding process produced by the wave action of the tides and wind. From the foot of the bank to low water the beach is covered with sand, which dries from a third of a mile at the south end to three-quarters of a mile at the northern end.

There is a very slow but continuous drift or movement of the boulders along the bank northwards. The progress of the ridge being stopped by the sand hills, the bank has bifurcated at this point, a new or double bank now forming, a circumstance which has occurred within the knowledge of those who have known the bank all their lives.

The boulders composing the ridge are in perpetual motion during the time that the bank is covered by the sea at spring tides. Even in calm weather in summer the whole face of the bank is continually changing under the influence of the wave action of the flood and ebb tide, which is of sufficient force to cause the movement of even large boulders. Observers who have carefully watched this movement and marked individual stones find that they are never in the same place two tides running, and each spring tide leaves its impress in a hollow and ridge at high-water mark.

In heavy on-shore gales these ridges and hollows are obliterated, and the face of the bank is pulled down seaward, the extent to which this is carried depending on the force and duration of the gale. After the storm, and when the height and force of the waves have subsided, the pebbles begin to move back again ; the contour of the bank becomes more steep, and is soon restored to its normal condition.

During the winter at the end of 1896 there was a succession of westerly gales, culminating in a very heavy gale from the north-west. The bank was torn down and so lowered that the waves broke over it and inundated the enclosed land. Some of the largest boulders were thrown over the top of the ridge and hurled a considerable distance inland, where they now remain as a witness to the force of the gale. The disturbance of the boulders was so great under the action of the waves, that after the gale it was found that the base of the bank was moved ten yards inland, the clay bed on which it had rested previously being exposed. A somewhat similar movement took place during a gale about twenty years previously.

The peculiarity of this pebble ridge, and the way in which it differs from ordinary shingle banks, is in the large size of the boulders drifted along the coast, and heaped up by the action of the waves and tides. W. H. WHEELER.

RANDOM SELECTION.

THIS memoir[1] is the first of a series dealing with the problem of selection, namely the measurement of the changes in the characters of a race, when selection has acted upon any one, two, or more of them. The problem mathematically differs considerably according to the nature of the selection. But in all cases the general result is the same, the selection of any organ, whether by size, variability, or correlation with other organs, changes the sizes, variabilities, correlations of all other organs, whether directly correlated with the first organ, or only indirectly correlated with it owing to correlation with other organs which are correlated with the first organ. (A and C may have no correlation with each other, but both be correlated with B, *e.g.* two parents in the absence of sexual selection and their offspring.) The chief types of selection which have to be treated independently are :—

(i.) *Random Selection* or *Sample Selection.*—The isolation of a group out of a larger population. This will generally have characters divergent from those of the general population, but which form in themselves a correlated system of divergences.

(ii.) *Epidemic Selection.*—Selection which takes place so quickly that the growth or reproduction of the population may be neglected. For example, a severe winter or a pestilence.

(iii.) *Auxetic Selection*, or long-continued selection which allows during its action for growth, but not for reproduction. For example, diseases of childhood.

(iv.) *Gonimic Selection*, or long-continued selection which allows during its action for reproduction. For example, physical and mental qualities, pressure of other populations. These forms of

[1] Contributions to the Mathematical Theory of Evolution. IV. On the Probable Errors of Frequency Constants, and on the Influence of Random Selection on Variation and Correlation, by Karl Pearson and L. N. G. Filon. (Royal Society, Nov. 25, 1897.)

selection require very different mathematical treatment; it is not at all clear, that they have always been sufficiently distinguished by writers on the theory of evolution. The above paper covers only the ground of the first kind of selection, random selection, but the memoir on epidemic selection is already completed, and the theory of the other cases advanced. The importance of random selection not only arises from the differentiation of species by isolation of small groups from a general population, but also from the fact that every measurement on a population is really a measurement on a more or less extensive random selection or sample. Hence the theory of random selection is also the theory of the probable errors of the frequency constants for any race. It enables us to determine the accuracy with which we have measured the chief racial constants.

Let the frequency-surface giving the distribution of a population with regard to n-organs be

$$z=f(x_1\ x_2,\ x_3\ \ldots\ x_n,\ c_1,\ c_2\ c_3\ \ldots\ c_q)$$

where $c_1\ c_2\ \ldots\ c_q$ are the q constants which determine the characters of the population. Then the surfaces for the distribution of the errors in $c_1,\ c_2\ \ldots\ c_q$ is given approximately by

$$z=z_0e^{-\frac{1}{2}(a_{11}\,e_1^2+2a_{12}e_1e_2+\ \ldots)}$$

where

$$a_{vu}=-\int\int\int\ \ldots\ z\,\frac{d^2\log z}{dc_v dc_u}\,dx_1dx_2\ \ldots\ dx_n$$

Higher terms can be evaluated if needful; we have then a skew correlation of the system of errors. Approximately the divergences of any random selection from the characters of the general population form in themselves a normally correlated system, and we can predict from a knowledge of the divergence in one character the probable divergences in all the others.

The general formulæ are applied to the problems of

(i.) *The random selection out of a population having* n *normally correlated organs.*

If one character be changed, say the variability of one organ be altered, it is shown how the probable changes in all the other characters may be found; for example, the changes in the correlation of other organs. This is the death-blow to any theory that either variability or correlation can be constant for local races.

(ii.) *Skew Variation*, for all the three types discussed in a previous memoir.

Criteria are obtained for determining when skewness is significant; when the mode really diverges from the mean, &c.

In many cases in which the normal curve of errors is used, the skewness is really significant, and thus many of the results used are illegitimate. For example, personal equation is generally sensibly skew, curves for size of organs during growth, and nearly all cases of botanical distribution.

These points are illustrated in the memoir by three numerical examples:—

(I.) Müllerian glands in the legs of swine; data from the observations of two American naturalists. The skewness can be determined with less than 5 per cent. of probable error. It is therefore significant, and the use by the above-mentioned biologists of the ordinary theory of errors is in this case to be deprecated.

(II.) Enteric fever. Skewness is known to 1 per cent. of probable error.

The effect of raising mean age, or altering the incidence, &c. on the character of the disease follows at once from the tables given.

(III.) Stature during growth; a critical case, taken because the distribution is almost normal. The skewness is, however, probably significant, and the influence indicated of random selection on stature during growth is in accordance with experience.

MODIFICATION OF THE GREAT LAKES BY EARTH MOVEMENT.[1]

THE history of the Great Lakes practically begins with the melting of the Pleistocene ice-sheet. They may have existed before the invasion of the ice, but if so their drainage system is unknown. The ice came from the north and north-east, and, spreading over the whole Laurentian basin, invaded the drainage districts of the Mississippi, Ohio, Susquehanna and Hudson. During its wandering there was a long period when the waters were ponded between the ice front and the uplands south of the Laurentian basin, forming a series of glacial lakes whose outlets were southward through various low passes. A great stream from the Erie basin crossed the divide at Fort Wayne to the Wabash river. A river of the magnitude of the Niagara afterwards flowed from the Michigan basin across the divide at Chicago to the Illinois river; and still later the chief outlet was from the Ontario basin across the divide at Rome to the Mohawk valley.

The positions of the glacial lakes are also marked by shore-lines, consisting of terraces, cliffs, and ridges, the strands and spits formed by their waves. Several of these shore-lines have been traced for hundreds of miles, and wherever they are thoroughly studied it is found that they no longer lie level, but have gentle slopes towards the south and south-west. Formed at the edges of water surfaces, they must originally have been level, and their present lack of horizontality is due to unequal uplift of the land. The region has been tilted towards the south-south-west. The different shore-lines are not strictly parallel, and their gradients vary from place to place, ranging from a few inches to three or four feet to the mile.

Early History of the Lakes.

The epoch of glacial lakes, or lakes partly bounded by ice, ended with the disappearance of the ice-field, and there remained only lakes of the modern type, wholly surrounded by land. These were formed one at a time, and the first to appear was in the Erie basin. It was much smaller than the modern lake, because the basin was then comparatively low at the north-east. Instead of reaching from the site of Buffalo to the site of Toledo, it extended only to a point opposite the present city of Erie, and it was but one-sixth as large as the modern lake. Since that time the land has gradually risen at the north, canting the basin towards the south, and the lake has gradually encroached upon the lowlands of its valley.

The next great lake to be released from the domination of the ice was probably Ontario, though the order of precedence is here not equally clear. Before the Ontario valley held a land-bound lake it was occupied by a gulf of the ocean. Owing to the different attitude of the land, the water surface of this gulf was not parallel to the present lake surface, but inclined at an angle. In the extreme north-east, in the vicinity of the Thousand Islands, the marine shores are nearly 200 feet above the present water level, but they descend southward and westward, passing beneath the lake level near Oswego, and towards the western end of the lake must be submerged several hundred feet. This condition was of short duration, and the rising land soon divided the waters, establishing Lake Ontario as an independent water body. The same peculiarity of land attitude which made the original Erie a small lake served to limit the extent of Ontario, but the restriction was less in amount because of the steeper slopes of the Ontario basin. Here again the southward tilting of the land had the effect of lifting the point of outlet and enlarging the expanse of the lake.

There is some reason to think that the upper lakes, Huron, Michigan and Superior, were at first open to the sea, so as to constitute a gulf, but the evidence is not so full as could be desired. When the normal lacustrine condition was established they were at first a single lake instead of three, and the outlet, instead of being southward from Lake Huron, was north-eastward from Georgian bay, the outlet river following the valleys of the Mattawa and Ottawa to the St. Lawrence. The triple lake is known to us chiefly through the labours of Mr. F. B. Taylor, who has made extensive studies of its shore-line. This line, called the Nipissing shore-line, is not wholly submerged, like the old shores of lakes Erie and Ontario, but lies chiefly above the present water surfaces. It has been recognised at many points about Lake Superior and the northern parts of lakes Huron and Michigan, and measurements of its height show that its plane has a remarkably uniform dip, at 7 inches per mile, in a south-south-west direction, or, more exactly, S. 27° W. The southward tilting of the land, involving the uplift of the point of outlet, increased the capacity of the basin and the volume of the lake, gradually carrying the coast-line southward in Lake Huron and Lake Michigan until finally it reached the low pass at Port Huron, and the water overflowed *viâ* the St. Clair and Detroit channels to Lake Erie. The outlet by way of the Ottawa was then abandoned, and a continuance of the

[1] Abridged from a paper, by Prof. G. K. Gilbert, in the *National Geographic Magazine* (September 1897).

uplift caused the water to slowly recede from its northern shores. This change after a time separated Lake Superior from the other lakes, bringing the St. Marys river into existence, and eventually the present condition was reached.

These various changes are so intimately related to the history of the Niagara river that the Niagara time estimates, based on the erosion of the gorge by the cataract, can be applied to them. Lake Erie has existed approximately as long as the Niagara river, and its age should probably be reckoned in tens of thousands or hundreds of thousands of years. Lake Ontario is much younger. All that can be said of the beginning of Great Lake Nipissing is that it came long after the beginning of Lake Erie, but the date of its ending, through the transfer of outlet from the Mattawa to the St. Clair, is more definitely known. That event is estimated by Taylor to have occurred between 5000 and 10,000 years ago.

The lake history thus briefly sketched is characterised by a progressive change in the attitude of the land, the northern and north-eastern portions of the region becoming higher, so as to turn the waters more and more towards the south-west. The latest change, from Great Lake Nipissing to Great Lakes Superior, Michigan and Huron, involving an uplift at the north of more than 100 feet, has taken place within so short a period that we are naturally led to inquire whether it has yet ceased. Is it not probable that the land is still rising at the north, and the lakes are still encroaching on their southern shores? Dr. J. W. Spencer, who has been an active explorer of the shore-lines of the glacial lakes, and has given much study to related problems, is of opinion that the movements are not complete, and predicts that they will result in the restoration of the Chicago outlet of Lake Michigan and the drying of Niagara.

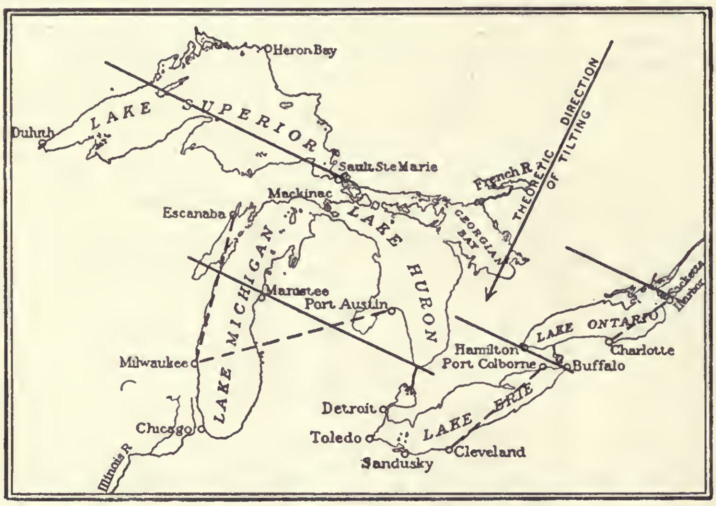

FIG. 1.—Map of the Great Lakes, showing pairs of gauging stations and isobases of outlets. The isobases are marked by full lines. Broken lines show the pairs of stations.

Measurements of Changes in the Shore-lines.

The importance of testing this question by actual measurements was impressed upon me several years ago, and I endeavoured to secure the institution of an elaborate set of observations to that end. Failing in this, I undertook a less expensive investigation, which began with the examination of existing records of lake height as recorded by gauge readings, and was continued by the establishment of a number of gauge stations in 1896.

If the volume of a lake were invariable, and if its water were in perfect equilibrium under gravity, its surface would be constant and level, and any variation due to changes in the height of the land could be directly determined by observations on the position of the water surface with reference to the land; but these conditions are never realised in the case of the Great Lakes, where the volume continually changes and the water is always in motion. The investigator therefore has to arrange his measurements so as to eliminate the effect of such changes.

The various oscillations of the water, though differing widely in amplitude, rate and cause, yet coexist, and they make the actual movement of the water surface highly complex. The complexity of movement seriously interferes with the use of the water plane as a datum level for the measurement of earth movements, and a system of observations for that purpose needs to be planned with much care. The main principles of such a system are, however, simple, and may readily be stated. The most important is that the direct measurement of the heights of individual points should not be attempted, but comparison should always be made between two points, their relative height being measured by means of the water surface used as a levelling instrument.

It will not be necessary to give here the details of observation and computation, as they are fully set forth in a paper soon to be printed by the U.S. Geological Survey, but the general scope of the work may be briefly outlined. As the tilting shown by the geological data was towards the south-south-west, stations were, so far as possible, selected to test the question of motion in that direction. The most easterly pair were Sacketts Harbour and Charlotte, New York, connected by the water surface of Lake Ontario (Fig. 1). From observations by the U.S. Lake Survey in 1874, it appeared that a bench mark on the old lighthouse in Charlotte was then 18·531 feet above a certain point on the Masonic Temple in Sacketts Harbour. In 1896 the measurement was repeated, and the difference found to be 18·470 feet, the point at Sacketts Harbour having gone up, as compared to the point at Charlotte, 0·061 foot, or about three-fourths of an inch. Similarly it was found that between 1858 and 1895 a point in Port Colborne, at the head of the Welland Canal, as compared to a point in Cleveland, Ohio, rose 0·239 foot, or nearly three inches. Between 1876 and 1896 a point at Port Austin, Michigan, on the shore of Lake Huron, as compared to a point in Milwaukee, on the shore of Lake Michigan, rose 0·137 foot, or one and one-half inches; and in the same period a point in Escanaba, at the north end of Lake Michigan, as compared to the same point in Milwaukee, rose 0·161 foot, or about two inches.

There is not one of these determinations that is free from doubt; buildings and other structures on which the benches were marked may have settled; mistakes may have been made in the earlier levelling, when there was no thought of subjecting the results to so delicate a test; and there are various other possible sources of error to which no checks can be applied. But the fact that all the measurements indicate tilting in the direction predicted by theory, inspires confidence in their verdict.

The stations of the several pairs are at different distances apart, the directions of the lines connecting them make various angles with the theoretical direction of tilting, and the time intervals separating the measurements are different. To reduce the results to common terms, I have computed from each the rate of tilting it implies in the theoretical direction, S. 27° W., and determined the change in relative height of the ends of a line 100 miles long during a century.

Compared in this way, the results are remarkably harmonious, the computed rates of tilting ranging only from 0·37 foot to 0·46 foot per 100 miles per century; and in view of this harmony it is not easy to avoid the conviction that the buildings are firm and stable, that the engineers ran their level lines with accuracy, that all the various possible accidents were escaped, and that we have here a veritable record of the slow tilting of the broad lake-bearing plain.

The computed mean rate of tilting, 0·42 foot per 100 miles per century, is not entitled to the same confidence as the fact of tilting. Its probable error, the mathematical measure of precision derived from the discordance of the observational data, is rather large, being one-ninth of the whole quantity measured. Perhaps it would be safe to say that the general rate of tilting, which may or may not be uniform for the whole region, falls between 0·30 and 0·55 foot.

Future of the Great Lakes.

The geographical effects of the tilting are of scientific and economic importance. Evidently the height of lake water at

a lake's outlet is regulated by the discharge, and is not affected by slow changes in the attitude of the basin; but at other points of the shore the water advances or retreats as the basin is tipped. Consider, for example, Lake Superior. On the map (Fig. 1) a line has been drawn through the outlet at the head of St. Marys River in a direction at right angles to the direction of tilting. All points on this line, called the *isobase* of the outlet, are raised or lowered equally by the tilting, and are unchanged with reference to one another. All points south-west of it are lowered, the amount varying with their distances from the line, and all points to the north-east are raised. The water, always holding its surface level, and always regulated in volume by the discharge at the outlet, retreats from the rising north-east coasts, and encroaches on the sinking south-west coasts. Assuming the rate of tilting to be 0·42 foot per 100 miles per century, the mean lake level is rising at Duluth 6 inches per century and falling at Heron Bay 5 inches. Where the isobase intersects the north-western shore, which happens to be at the international boundary, there is no change.

Lake Ontario lies altogether south-west of the isobase of its outlet, and the water is encroaching on all its shores. The estimated vertical rise at Hamilton is 6 inches per century. The whole coast of Lake Erie also is being submerged, the estimated rate at Toledo and Sandusky being 8 or 9 inches per century.

The isobase of the double Lake Huron-Michigan passes south-west of Lake Huron and crosses Lake Michigan. All coasts of Lake Huron are therefore rising as compared to the outlet, and the consequent apparent lowering of the mean water surface is estimated at 6 inches per century for Mackinac, and at 10 inches for the mouth of the French river on Georgian Bay. In Lake Michigan the line of no change passes near Manistee, Michigan. At Escanaba the estimated fall of the water is 4 inches per century; at Milwaukee the estimated rise is 5 or 6 inches, and at Chicago between 9 and 10 inches.

These slow changes of mean water level are concealed from ordinary observation by the more rapid and impressive changes due to variations of volume, but they are worthy of consideration in the planning of engineering works of a permanent character, and there is at least one place where their influence is of moment to a large community. The city of Chicago is built on a smooth plain little above the high-water level of Lake Michigan. Every decade the mean level of the water is an inch higher, and the margin of safety is so narrow that inches are valuable. Already the older part of the city has lifted itself several feet to secure better drainage, and the time will surely come when other measures of protection are imperatively demanded.

Looking to the more distant future, we may estimate the date at which the geographical revolution, prophesied by Spencer, will occur. Near Chicago, as already mentioned, is an old channel made by the outlet of a glacial lake. The bed of the channel at the summit of the pass is about 8 feet above the mean level of Lake Michigan and 5 feet above the highest level. In 500 or 600 years (assuming the estimated rate of tilting) high stages of the lake will reach the pass, and the artificial discharge by canal will be supplemented by an intermittent natural discharge. In 1000 years the discharge will occur at ordinary lake stages, and after 1500 years it will be continuous. In about 2000 years the discharge from Lake Michigan-Huron-Erie, which will then have substantially the same level, will be equally divided between the western outlet at Chicago and the eastern at Buffalo. In 2500 years the Niagara river will have become an intermittent stream, and in 3000 years all its water will have been diverted to the Chicago outlet, the Illinois river, the Mississippi river, and the Gulf of Mexico.

FORESTS AND RAINFALL.[1]

CAN it be possible that the cutting away of forests affects the amount of precipitation in any locality? To many, no doubt, this question will seem easy of answer; but we find the results of study by no means reassuring, and recent investigations have led to almost diametrically opposite conclusions, depending, somewhat at least, upon the feeling of the writer. When we reflect that our rain storms are of very wide extent, oftentimes over 1000 miles in diameter, and may take their origin and bring their moisture from distances of 1000 miles or more, the thought that man, by his puny efforts, may change their action, or modify it in any manner, seems ridiculous in the extreme.

It has been well established that forests have a most important bearing upon the conservation of rainfall; that the forest floor permits a seepage of water to the source of springs, and thus maintains their steady flow; that they hold back the precipitation that falls, especially in the form of snow, thus preventing or ameliorating the effects of dangerous freshets. There is not the slightest doubt of their great importance to the welfare of man, but all these facts do not affect the question of their influence upon precipitation. The following paper is prepared from the standpoint of a meteorologist, and is an attempt to present facts.

The Historical Argument.

Formerly the historical argument was a favourite one. I quote one of these: "It is a familiar fact that there are many regions in Asia and southern Europe, once exceedingly fertile and densely populated, that are now utterly sterile and desolate. The country bordering on the Euphrates and portions of Turkey, Greece, Egypt, Italy and Spain are now incapable of cultivation from lack of rain due to deforestation." The most fertile of all provinces in Bucharia was that of Sogd. Malte Brun said, in 1826, "For eight days we may travel and not be out of one delicious garden." In 1876 another writer says of this same region: "Within thirty years this was one of the most fertile spots of central Asia, a country which, when well wooded and watered, was a terrestrial paradise. But within the last twenty-five years a mania of clearing has seized upon the people, and all the great forests have been cut away, and the little that remained was ravaged by fire during a civil war. The consequences followed quickly, and this country has been transformed into a kind of arid desert. The water-courses are dried up and the irrigating canals are empty." It has also been said that in the older settled portions of New England and the Middle States there are arid hills and worn-out fields, due to the falling off of precipitation from the cutting away of the forest growth. Such quotations and statements might be made to fill a large volume. Without more precise data as to rainfall it would be hazardous to conclude that we have here a case of cause and effect. It is certain that the fertility of these regions in ancient times was due to stupendous irrigating devices and canals, and when these were neglected, through wars and other untoward circumstances, the fertility necessarily ceased. It is certain that there are ruins of enormous irrigating ditches and canals in Babylonia, where history indicates that there was once a teeming population and great fertility, but where now only a sandy desert greets the eye.

Constancy of Rainfall.

It has been said that where our densest forests are found there we have the greatest precipitation. There is no way whereby we can see that such forests would have started unless favoured by rainfall, so that the presence of the forest rather indicated the earlier occurrence of practically the same rainfall as at present. Meteorologists are agreed that there has been practically no change in the climate of the world since the earliest mention of such climates. Plants found in mummy cases in Egypt that were plucked thousands of years ago show the same size as those now found in that land. The "early and the latter rains" are experienced in Palestine to-day just as they were four thousand years ago. Jordan "overflows all its banks" to-day, in February, precisely as it did in Joshua's day. When we come down to recent times and to the records of rainfall measured in New England for more than one hundred years, or, at least, before and since the forests were cut, we find a constancy in the rainfall which shows its entire independence of man's efforts. Here it should be noted that totally barren lands of any extent, in New England for example, are to be found only in imagination. Even where the forest has been cut away mercilessly there springs up a growth of sprouts which covers the ground, and answers almost the same purpose in causing rainfall (if there is any effect of that kind) as the forest. Even where land is entirely cleared of a forest we have at times the green pasture, and at others still heavier crops which leave the ground anything but a sandy waste.

Rainfall Measurements in Forests and Open Fields.

But the strongest argument adduced in the past to show the influence of forest on rainfall has existed in a comparison between rain-gauge measures in the forest and the open field

[1] A paper by Prof. H. A. Hazen, presented at the annual meeting of the American Forestry Association at Nashville, Tenn., September 22. (Abridged from the *Monthly Weather Review*)

Such records have been made for more than thirty years in France and Germany, and surely we must have here, if anywhere, a sufficient proof of a forest's influence.

Admitting that we have perfect instruments and careful observers, there still remains a most serious doubt as to the immediate environment of each gauge and as to the possibility of a direct comparison. It is probable that no two gauges 2000 feet apart can be placed so as to catch the same amount of rain, though to all appearances the exposure is faultless in each case.

Extreme caution is therefore needed in arriving at conclusions from comparisons between gauges in forests and in the open. One of the best of all researches in this line has been conducted at Nancy, in France. Within a distance of five or six miles there have been four stations established. At Nancy in the open, and at Belle-Fontaine in the forest; and, 500 feet higher vertically, Amance (open) and Cinq-Tranchées (forest). At Nancy and Belle-Fontaine the observations extend over twenty-five years. A comparison of the records in groups of eight, eight, and nine years was made, with the result that while the first eight years showed a very slight excess in the forest rainfall over that in the open field, in the last nine years (including 1894, last published) the open station showed a little more rain than the forest station. These observations were made with particular care, for the purpose of exactly determining the influence, and may be relied on if the environments of the gauges were comparable. At Amance (open) and Cinq-Tranchées (forest) the observations have not been quite so regular, though there are twenty-five full years of records at these two stations, but not the same years as at the other stations. The comparison in this case makes the rainfall more than 20 per cent. greater in the forest than in the open. It should be borne in mind, however, that these two stations are on an eminence, and are not strictly comparable, and this result cannot vitiate that at the two other stations, which shows no effect.

In Germany we have a rather remarkable record of a slightly different character. Lintzel is a station on the Luneburg Heath, which began to be planted with trees in 1887, at the rate of 1000 to 1500 acres a year, and in a few years over 8000 acres were covered. In the midst of this forest is the meteorologic station in an open field of some seventy-five acres. Before planting the forest, 97 per cent. of the surface was field, meadow, or heath, and afterwards 80 per cent. was forest and 20 per cent. was roads, open field, and heath. Around this station, pretty evenly distributed, and within fifty miles, there are thirteen rainfall stations which have been carefully established, and presumably are comparable with the Lintzel station in the midst of the growing forest. There are no means of knowing whether any of these stations have been changed or not, but for our purpose we may consider the material homogeneous, and treat it accordingly. Records from 1882 to 1896 (fifteen years) are available. Charts were prepared for each year showing the ratio between the Lintzel record and that at each station of the thirteen. The results do not show that the afforestation has had any appreciable effect upon the precipitation; in 1884 the ratio was 101, while in 1893, nine years later, it was 96. It is probable, however, that no definite and unassailable result can ever be obtained either by the method adopted in France or this later one in Germany. The rainfall is so variable within a distance of even a mile or two; and it is so difficult, if not impossible, to obtain similar environments at all the stations, that no decisive result can be obtained. It will be readily seen that the multiplication of stations will do no good, and, above all, that the observation of rainfall under trees in a forest is absolutely useless for any such discussion or study as this.

Need of Further Evidence.

It seems probable that if two or three lines of stations could be established a mile or two apart on four sides of an enormous forest, each line to have a dozen stations or so, about 3000 feet apart, four of the stations to be outside of the forest, and the others each in a large cleared space of at least two acres extent in the forest, something decisive might be obtained. It should be noted, however, that from the evidence already accumulated there would be very little to be gained by a further study of the question. It is certain that the effect, if there be one, is almost inappreciable. The favouring conditions over the forest are balanced by those not favouring, and the integrated effect is practically the same in the two cases.

Prof. H. F. Blanford determined from a most careful series of records, from which all known errors had been eliminated, that the forest had a tendency to give 2 per cent. more rain than contiguous open fields. That is, if an open place had 50 inches of rain in a year, a near-by forest would have only 51 inches, which is practically inappreciable.

It would be an interesting study to select all those cases in experiments in forest and near-by fields in which the wind was blowing either from the forest to the field, or *vice versâ*. It is evident that if there is any effect on rainfall by the forest, it would be vitiated, if not exactly reversed by such winds.

There is a class of visual observations which seem to show an effect upon rainfall by the forest. Probably many have seen heavy clouds passing over a plain, but which only precipitated as they passed over a forest. Also in a hilly region it is a frequent phenomenon that fog and low-lying cloud hover near a forest, and not over an open plain. One also notes very often, in passing into a forest on a damp day, that the trees drip moisture, possibly condensed from moisture evaporated from the damp earth underneath. Observations of this nature, however, cannot ordinarily be checked by instrumental means, but show in a general way that the forest tends to conserve vapour and moisture which in the case of the open field would be diffused into the atmosphere.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. G. H. RENDALL, the Principal of University College, Liverpool, has been appointed Head-Master of Charterhouse School.

SIR JOHN GORST, in the course of an address at Bristol on Thursday last, is reported by the *Times* to have said that the promotion of technical education was confronted by two obstacles—the backward condition of elementary education and the want of organisation in the provision of secondary education. A good sound system of elementary education must be the groundwork for higher education, and he urged reform of the system which at present relieved children from compulsory attendance when inadequately equipped. The improvement of the organisation of secondary schools was really a matter for the people themselves. There was nothing to prevent technical instruction committees from becoming thoroughly representative and effective organisations.

THE most satisfactory point to us in the Report just issued by the Oxford University Extension Delegacy refers to the Extension College at Reading. The college is doing excellent work, more particularly in agriculture, and has amply justified its existence. New buildings are, however, imperatively needed, and in response to an appeal for 12,000*l*., 9,000*l*. has already been promised, and the new wing has been begun. The building scheme, planned four years ago, will be completed by next summer, and H.R.H. the Prince of Wales has promised to perform the opening ceremony. The educational work of the college has been attended with great success during the past year. With regard to the courses of lectures delivered under the auspices of the Delegacy during the year 1896–97, we notice that out of a total of 146 courses, only nineteen were on scientific subjects.

IN the course of a presidential address recently delivered before the Kansas Academy of Sciences, Prof. S. W. Williston severely criticised the system of education which makes language studies compulsory, and all, or nearly all, the sciences optional. Many educationists will find themselves in agreement with the following opinions expressed by Prof. Williston:—"I claim broadly and emphatically that the natural sciences, any or all of them, are as valuable and as necessary as pure cultural studies as are the languages; that intelligent and successful study of them will do as much, if not more, in making the student a broad man, a successful man, as will the study of Latin or Greek. And they will do more in making him an honest man. Nowhere in all the broad field of knowledge will he learn better to think exactly than in the natural sciences. Nowhere will he be more impressed with the importance of truth for truth's sake. . . . Were I, then, to say what the universities and colleges ought to do, it would be this: make all the ancient language requirements for admission optional, and demand as much preparation in the physical and biological sciences as in the foreign languages. The preparation in English should be made far more rigorous

and thorough. In the college course, if anything besides English is required, and I think there should be, I would have the natural science as necessary a part of the education as language and mathematics. I would not have it possible for a student to graduate from the college without having studied, and thoroughly studied, mathematics as far as trigonometry, at least one foreign language, and at least one physical and one biological science. And I do not mean a few weeks of study in any of these branches, but exhaustive, careful, critical study. The methods of study in all these branches are diverse, and are absolutely essential for symmetrical mind-building."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 25.—"Further Note on the Transplantation and Growth of Mammalian Ova within a Uterine Foster-Mother." By Walter Heape, M.A., Trinity College, Cambridge.

In 1890 an experiment was recorded (*Roy. Soc. Proc.*, vol. xlviii.), designed to show that it is possible to make use of the uterus of one variety of rabbit as a medium for the growth and complete fœtal development of fertilised ova of another variety of rabbit. The experiment was further undertaken in order to determine what effect, if any, a uterine foster-mother would have upon her foster-children, and whether or not the presence, during development, of foreign ova in the uterus of a mother would affect offspring of that mother present in the uterus at the same time. In this experiment, two fertilised ova obtained from an Angora doe rabbit which had been inseminated thirty-two hours previously by an Angora buck, were inserted into the fallopian tube of a Belgian Hare doe, which had been inseminated three hours before by a buck of the same breed as herself; and in due course the Belgian Hare doe littered six young, four of which were Belgian Hares, while the other two were Angoras. This year experiments were made with Dutch and Belgian Hare rabbits, and the method adopted was the same as that described above, the result being that the Belgian Hare foster-mother gave birth to seven young, of which five were Belgian Hares and two were apparently Dutch. Both these Dutch young were, however, irregularly marked, and it appeared possible, after all, either (1) that the Belgian Hare foster-mother had influenced the Dutch fertilised ova, or (2) that these two young were really a cross between Dutch and Belgian Hare.

In order to test the first of these possibilities, the same Dutch buck was put to a tried, thoroughbred Dutch doe, and she produced a litter, every one of which was badly marked, thus showing that the bad marking of the foster-children can be justly attributed to their father's influence. The second possibility was more difficult to test. A cross between the Dutch buck and the Belgian Hare foster-mother was obviously possible, for when the foreign Dutch segmenting ova were introduced into the fallopian tube of the Belgian Hare foster-mother, they were still surrounded by spermatozoa from the Dutch buck, which were still alive, though failing in vigour. But the Belgian Hare doe had been inseminated by a Belgian Hare buck just before the operation, and the spermatozoa from this buck would arrive at the end of the fallopian tube before ovulation took place; it would be at least twenty-four hours younger than the foreign Dutch spermatozoa, and both more vigorous and in far greater numbers than the latter. The possibilities are distinctly in favour of the host of younger and more vigorous Belgian Hare spermatozoa beating the few older and less vigorous, foreign, Dutch spermatozoa in the struggle for the Belgian Hare ova; but, at the same time, it is possible that the latter won. The only way to test this at all seemed to be by crossing the same Dutch buck with Belgian Hare does, and comparing the offspring of such crosses with the young foster-children. This was done, and two Belgian Hare does each produced, in consequence, five young. Of these, three were Belgian hares splashed with white, one was black and white, three were fawn or fawn and white (the fawn being mixed with a delicate bluish dun shade), and three were thoroughbred Belgian Hares. The father's influence was seen in the introduction of white and in the fawn and dun colours. None of the young, however, at all closely resembled the Dutch breed.

With regard to the foster-children, one of them died at an early age, but the second lived, and is now more typically Dutch than it was when younger; it is coloured and shaped remarkably like the Dutch doe from which the foreign fertilised ova were obtained. The remarkable likeness is in itself very strong evidence of the origin of this young one, and when considered in conjunction with the results obtained by crossing the Dutch buck with Belgian Hare does, there can be little doubt it was derived from Dutch parents. This result, supported by the result obtained in 1890, is greatly in favour of the contention, that it is possible to make use of a uterine foster-mother, and to do so without thereby influencing any of the young which are nourished by her.

It is worthy of notice, if the above is true, that in case telegony be actually demonstrated, the characteristics of a primary husband transmitted to the offspring got by a secondary husband, can only be so transmitted through the ova of the mother.

"Mathematical Contributions to the Theory of Evolution. IV. On the probable Errors of Frequency Constants and on the Influence of Random Selection on Variation and Correlation." By Karl Pearson, F.R.S., and L. N. G. Filon, University College, London.

A brief indication of the nature of the contents of this paper is given on p. 210.

December 9.—"On the Calculation of the Coefficient of Mutual Induction of a Circle and a Coaxial Helix, and of the Electromagnetic Force between a Helical Current and a Uniform Coaxial Circular Cylindrical Current Sheet." By J. Viriamu Jones, F.R.S.

Zoological Society, December 14.—Lieut.-Colonel H. H. Godwin-Austen, F.R.S., Vice-President, in the chair.—Mr. G. A. Boulenger, F.R.S., offered some further remarks upon the Siluroid Fish, *Vandellia cirrhosa*.—A communication was read from Dr. E. A. Goeldi, "On *Lepidosiren paradoxa* from the Amazons." This memoir treated of the geographical distribution of the *Lepidosiren* on the Amazons, and of its external structure and dimensions, and gave an account of its habits in a natural and captive state.—Mr. J. Graham Kerr gave an account of his recent expedition, along with Mr. Budgett, to the Chaco of Paraguay in quest of *Lepidosiren*: and made remarks on its habits as there observed. Mr. Kerr also gave a general account of the early stages of its development, drawing special attention to the presence in the larva of external gills and a sucker similar to those of the Amphibia.—A communication was read from Dr. A. G. Butler, containing a list of thirty-three species of butterflies obtained by Mr. F. Gillett in Somaliland during the present year, and giving the dates of the capture of the specimens and their localities.—Mr. Oldfield Thomas read a paper entitled "On the Mammals obtained by Mr. A. Whyte in North Nyasaland, and presented to the British Museum by Sir H. H. Johnston, K.C.B.; being a fifth contribution to the Mammalogy of Nyasaland." This memoir contained notes on sixty-one species of Mammals, four of which were characterised as new, viz. *Macroscelides brachyrhynchus malosæ*, *Crocidura lixa*, *Myosorex soulla*, and *Graphiurus johnstoni*.—A communication was read from the Rev. O. Pickard Cambridge, F.R.S., describing a new genus and species of Acaridea (*Eatonia scopulifera*) from Algeria.—A communication by Mr. J. Stanley Gardiner, "On some collections of corals of the family *Pocilloporidæ* from the South-west Pacific Ocean," was read by the author. Twenty species of the genus *Pocillopora* and one of the genus *Seriatopora* were enumerated and remarked upon, five species of the former genus being described as new, viz. *Pocillopora septata*, *P. obtusata*, *P. coronata*, *P. rugosa*, and *P. glomerata*.—Mr. W. E. de Winton gave an account of a collection of Mammals from Morocco, made by Mr. E. Dodson on behalf of Mr. J. I. S. Whitaker. Twenty-one species were enumerated as represented in the collection, of which the following were described as new: *Crocidura whitakeri*, *Mus peregrinus*, and *Lepus atlanticus*.

DUBLIN.

Royal Dublin Society, November 17.—Dr. F. T. Trouton, F.R.S., in the chair.—Dr. G. Johnstone Stoney, F.R.S., presented a paper upon atmospheres upon planets and satellites (see p. 207).—Mr. W. E. Wilson, F.R.S., read a paper upon the apparent cometary nature of the spiral nebula in Canes Venatici. The paper was illustrated by a remarkably fine photograph of the nebula taken in February 1897, by the author.—Dr. F. T. Trouton read a paper upon the arrangement of the crystals of

certain substances on solidification.—Prof. A. C. Haddon presented a paper upon the Actiniaria of Torres Straits. This account of the Actiniaria is based mainly on the collections made by the author in 1888–9, supplemented by descriptions published by Mr. Saville-Kent in his works "The Great Barrier Reef of Australia" and "The Naturalist in Australia." In order to render the paper more complete, allusions are made in it to genera which are not recorded from Torres Straits. In a second paper, Prof. Haddon described a new species of Actiniaria from Oceania—*Phellia Sollasi*. This was collected by Prof. Sollas in the lagoon at Funafuti, Ellice Group, W. Pacific, in 1896.—The following objects were exhibited at this meeting: The Coccoliths of Dublin Bay, by Mr. H. H. Dixon, and Prof. J. Joly, F.R.S.—A collection of economic plant products from the Gold Coast, by Prof. T. Johnson.

ST. LOUIS.

Academy of Science, December 6.—Mr. Julius Hurter exhibited specimens of a considerable number of reptiles and batrachians, mostly of southern origin, which had been collected by him during the past season, and were additions to the known fauna of Missouri. Among the more interesting additions were the cotton-mouth moccasin, the banded water snake, Holbrook's water snake, the little brown snake, the Louisiana mud turtle, the chestnut-backed salamander (first detected west of the Mississippi River by Mr. Colton Russell), and the marbled salamander.—Mr. H. von Schrenk exhibited a series of specimens and drawings illustrating some of the injuries inflicted on the trees of St. Louis by the tornado of May 1896, showing not only the formation of double twig elongation and growth rings, but the exfoliation of the bark and the consequent drying out of 50 per cent. or more of the wood through the trunk and branches, in several species.

NEW SOUTH WALES.

Linnean Society, October 27.—Prof. J. T. Wilson, President, in the chair.—Descriptions of new species of Australian Coleoptera, Part 4, by Arthur M. Lea. Thirty-four species, principally belonging to the *Curculionidæ*, were described as new; with critical notes and remarks on synonymy.—On the lizards of the Chillagoe district, North Queensland, by Dr. R. Broom. Twenty-three species were collected during a six months' residence at Muldiva, seventy miles west of Herberton, a district in which during eight months of the year (April–December) as a rule there is practically no rain. A species of *Lygosoma* was described as new.—On a *Trachypterus* from New South Wales, by J. Douglas Ogilby. In this paper the author gave a detailed description of a young example washed ashore near Newcastle, and reviewed at length our present knowledge of the genus in the south-western Pacific.—Contributions to a more exact knowledge of the geographical distribution of Australian Batrachia, No. 5, by J. J. Fletcher. The present contribution is based upon the examination of collections from Tasmania and West Australia. In the British Museum Catalogue (second edition) seven (? eight) species are attributed to Tasmania, and fourteen to West Australia. Three additional species are now recorded for the former Colony, and six for the latter, including an undescribed species of *Crinia* belonging to the group having the abdominal surface non-granulate.—Mr. Froggatt exhibited a number of scale insects (*Eriococcus coriaceus*, Mask.), upon a twig of Eucalyptus, among which had been placed a great number of the eggs of the scale eating moth *Thalpochares coccophaga*, Meyr. The eggs are pale pink, circular, and beautifully ribbed. The scales were infested with the larvæ of *Cryptolæmus montrouzieri*, Muls., a useful small black ladybird beetle. Both these enemies of *Eriococcus* are of great economic value, as the moth larvæ have now taken to eating the olive scale (*Lecanium oleæ*, Sign.), and the ladybird beetle is bred both in New Zealand and America. Also living specimens of our largest white ant, *Calotermes longiceps*, Froggatt, which were taken out of a log of fire-wood, and had already been in captivity for over two months.

DIARY OF SOCIETIES.

MONDAY, JANUARY 3.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Standard Methods of Tanning Analysis as adopted by the International Association of Leather Trades Chemists, with Remarks thereon: Prof. H. R. Procter and Dr. J. G. Parker.—Extraction of Tanning Materials at various Temperatures: Dr. J. G. Parker.—Neatsfoot Oil: J. H. Coste and E. J. Parry.

VICTORIA INSTITUTE, at 4.30.—Ancient Civilizations: Rev. John Tuckwell.

TUESDAY, JANUARY 4.

ROYAL INSTITUTION, at 3.—The Principles of the Electric Telegraph: Prof. Oliver Lodge, F.R.S.

ROYAL VICTORIA HALL, at 8.30.—Coal: W. F. Rudler.

WEDNESDAY, JANUARY 5.

GEOLOGICAL SOCIETY, at 8.—On the Structure of the Davos Valley: A. Vaughan Jennings.—Sections along the Lancashire, Derbyshire, and East Coast Railway, between Lincoln and Chesterfield: C. Fox-Strangways.

THURSDAY, JANUARY 6.

ROYAL INSTITUTION, at 3.—The Principles of the Electric Telegraph: Prof. Oliver Lodge, F.R.S.

FRIDAY, JANUARY 7.

GEOLOGISTS' ASSOCIATION, at 8.—A Brief Account of the Excursions in the Urals, down the Volga, in the Caucasus, &c., made in connection with the Interntional Geological Congress held in Russia, August–September, 1897: L. L. Belinfante.

SATURDAY, JANUARY 8.

ROYAL INSTITUTION, at 3.—The Principles of the Electric Telegraph: Prof. Oliver Lodge, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—L'Electro-chimie: A. Minet (Paris, Gauthier-Villars).—Introduction to the Study of Organic Chemistry: J. Wade (Sonnenschein).—Natürliche Schöpfungs-Geschichte: Prof. E. Haeckel, 2 Vols., Neunte Umgearbeitete Auflage (Berlin, Reimer).—Notes on Carpentry and Joinery: T. J. Evans, Vol. 1 (Chapman).—What is Life?: F. Hovenden (Chapman).—The Collected Mathematical Papers of Arthur Cayley, Vol. xiii. (Cambridge University Press).—Physikalisch-Chemische Propaedentik: Prof. H. Griesbach, Zweite Hälfte, 2 Liefg (Leipzig, Engelmann).

PAMPHLETS.—Magnetic and Pendulum Observations: G. R. Putnam (Boston, Mass.).—Hand-Guide to the Botanic Gardens, Buitenzorg (Batavia, Kolff).

SERIALS.—Traité Encyclopédique de Photographie: Dr. C. Fabre, Cinq^e Fasc. B. (Paris, Gauthier-Villars).—Journal of the Royal Microscopical Society, December (Williams).—Century Magazine, January (Macmillan).—Quarterly Journal of Microscopical Science, December (Churchill).—Natural Science, January (Dent).

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THURSDAY, JANUARY 6, 1898.

CAYLEY'S PAPERS.

The Collected Mathematical Papers of Arthur Cayley, Sc.D., F.R.S. Vols. viii., ix. Pp. liv + 570, xvi + 622. (Cambridge: at the University Press, 1895, 1896.)

THESE two volumes form the first of those published after Cayley's death in 1895. The first thirty-eight sheets of Vol. viii. were revised by the author, who added a note on one paper (No. 518); the duty of editing the rest of the papers was entrusted to Prof. Forsyth, who has very faithfully carried out the plan and arrangements which, in the absence of definite instructions, he was able to infer from the previous volumes.

Perhaps the reader's first impression after surveying these 144 papers, mostly published in the years 1871–77, is that they are very miscellaneous, and that comparatively few are of paramount importance. The fact is that Cayley is, as it were, brought into unfavourable comparison with himself; short notes on special problems of geometry and analysis, and solutions of Smith's Prize papers cannot rank with the immortal "Memoirs on Quantics," or some of the earlier geometrical papers, such as that upon plane cubic curves. But it is unreasonable to expect an artist to produce an uninterrupted succession of masterpieces; and it is to be remembered that Cayley seldom, if ever, wrote upon any subject without developing some instructive point or giving an example of his own characteristic elegance.

In trying to give some account of the more important of these memoirs it will be convenient to take the geometry and the analysis separately. Not that the boundary line is very easy to fix: Cayley was never a geometrician in the sense in which the word may be applied to Apollonius or Steiner. But some of the papers have an interest mainly geometrical, although the methods used are almost wholly algebraic; and with them we will begin.

Perhaps the most important are those which deal with transformation, correspondence, and the singularities of algebraical curves and surfaces. With these difficult theories Cayley dealt in a masterly way: he avoided, as if by instinct, the many opportunities of mistake which present themselves in a method which is largely enumerative, and he had the gift of predicting general results from the consideration of special cases.

Coming next to what may be called the metrical geometry of surfaces, which has developed so greatly in recent years, we have papers on curves of curvature, on geodesics on quadrics, and on orthogonal surfaces. To this group may perhaps be added a paper on evolutes and parallel curves, though this is rather meant to illustrate the non-Euclidian geometry.

There are three monographs, on Steiner's surface, on the centro-surface of an ellipsoid, and on the configuration of the twenty-seven lines of a cubic surface, which are in various ways highly characteristic. As models of analytical skill they are admirable; and as helps to the understanding of the geometrical figures with which they deal, they are of great service. But it is curious to see how chary the author is in giving illustrative diagrams. There are, indeed, two figures in the paper on the surface of centres; but why, we ask, did Cayley not give a series of contour lines of the surface? or again, with still more reason, in the case of Steiner's surface? Then the paper on the twenty-seven lines of a cubic surface is so quaint in its topsy-turveydom as almost to suggest Mr. W. S. Gilbert as joint author. Here we have a projective configuration which may be realised with the help of a bundle of sticks and without any measurement whatever. What Cayley did was to take a model by Dr. Wiener, measure approximately the coordinates of a number of points upon it, thence find the approximate equations of the lines, and finally adjust the equations so as to satisfy the geometrical conditions! Of course there is reason in this seeming perversity: by the projective method it is not easy to get a convenient arrangement of the sticks, whereas Cayley's equations make it possible to construct a string model on a cardboard frame without a tiresome series of preliminary experiments.

The poristic polygons of Poncelet appear to have had for Cayley a perennial charm: we have here two papers suggested by Poncelet's results; one "On the porism of the in-and-circumscribed polygon, &c.," which treats of the original problem, and the other "On the problem of the in-and-circumscribed triangle," which really deals with a rather different and more general theory. Cayley, like many others, does not seem to have been aware (at least in 1871) that the complete algebraical solution of the Poncelet problem was published in 1863 in a paper by M. Moutard, which formed part of the appendix to Poncelet's "Applications d'Analyse à la Géométrie." Not only is this so, but, as Halphen pointed out, this paper contains the first fully satisfactory treatment of the multiplication of the argument in elliptic functions.

Before passing on from the geometrical papers, attention should be called to the very interesting series of notes on the mechanical description of curves. This is a promising field of research, and the results could hardly fail to be of interest, especially to those who like to see the deductions of theory embodied in an actual geometrical figure. There is an æsthetic satisfaction in this contemplation: and, moreover, a really correct figure often suggests geometrical truths that would otherwise be overlooked.

Of the analytical papers the one which has been most appreciated in this country is, beyond question, the short paper "On the theory of the singular solutions of differential equations of the first order" (*Messenger*, vol. ii. (1873) pp. 6–12). Here Cayley's power of giving to analysis a geometrical interpretation appears to the best advantage. If we have an algebraical relation $f(x, y, p) = 0$ in which p enters to the degree s, then this associates with any point (x, y) a series of s (real or imaginary) directions corresponding to the different values of p: in other words, the differential equation really expresses that the plane of reference is covered with ∞^2 tiny s-rayed stars. The primitive $\phi(x, y, c) = 0$ gives a family of ∞^1 curves each made up of ∞^1 selected rays. Now if we eliminate p from $f(x, y, p) = 0$, $\partial f / \partial p = 0$, we obtain a locus of points (x, y) at each of which two rays coincide in direction; where this happens either two consecutive curves $\phi(x, y, c) = 0$ touch, or

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two non-consecutive curves touch, or (x, y) is a cusp or point of self-contact of one particular curve $\phi(x, y, c)=0$. Thus we may have the envelope of the family of curves, a tac-locus, or a locus of cusps or of points of self-contact. On the other hand if we eliminate c from $\phi(x, y, c)=0$ and $\partial\phi/\partial c=0$, we get the locus of intersection of consecutive curves ϕ: this may include besides the envelope proper, a locus of nodes, of cusps, or of multiple points of higher order (as, for instance, points of self-contact or triple points). The only outstanding difficulty is the degree of multiplicity in which the singular loci, distinct from the envelope, are involved in the two discriminants.

There are six papers on the transformation of elliptic functions, the most important being No. 578. This contains an exposition of the Jacobian theory, Sohnke's modular equations with additions, and a discussion of the singularities of some of the modular curves. It is remarkable that Cayley, like Kronecker, adhered firmly to Jacobian methods, and never seems to have worked with the Weierstrassian forms. Perhaps just now there is a rather exaggerated tendency in the other direction: as Prof. Klein has pointed out, both theories are self-consistent and form, in a sense, the first and second stages in a complete discussion of periodic functions.

There is not very much about invariants and co-variants; No. 525 is an interesting example of a quadratic transformation, and the papers on "trees," although ostensibly intended for application to chemistry, were suggested by the invariant calculus.

In arithmetic there is a table of reduced binary cubics with their Hessians, which is a development of Arndt's results. Cayley gives the composition tables for the Hessians.

Volume ix. contains eleven papers dealing more or less with astronomy and dynamics; and it may be worth while to notice that this volume also contains a reprint of the British Association "Report on Mathematical Tables."

Many interesting special points suggest themselves to the reader: thus, to mention only three, very different in character, the very simple and pretty proof of Vandermonde's theorem (viii. p. 465) might very well find a place in an elementary text-book of algebra; we are told (*ibid.*, p. 188) how a theoretical error was detected by a numerical calculation; and (*ibid.*, p. 397) there is an unverified conjecture that every surface of negative deficiency may be derived by a rational transformation from a cone whose deficiency is equal to that of the surface with its sign changed. G. B. M.

EXPERIMENTAL PHYSICS.

The Outlines of Physics. By Prof. E. L. Nichols. Pp. xi + 452. (London: Macmillan and Co., Ltd., 1897.)

Lessons in Elementary Practical Physics. Vol. iii. Part i. *Practical Acoustics.* By C. L. Barnes. Pp. x + 214. (London: Macmillan and Co., Ltd., 1897.)

THE first of these books, as the author explains in his preface, is an attempt to "outline a short course in physics which shall be a fair equivalent for the year of advanced mathematics now required for entrance to many colleges"; and he proceeds to point out that if physics is to possess much disciplinary value, it must be taught by laboratory methods. Experimental work thus finds a prominent place in his book, which may, in fact, be roughly described as a series of experiments, mostly suitable for repetition by young students, connected by short discussions of a theoretical character.

With the author's object we imagine that most teachers of physics will cordially sympathise. That experiment is the means whereby a knowledge of physics should be acquired by beginners, is as clear now-a-days as it is that the means itself is open to improvement—at any rate, in its early stages. Whether the author has made the most of his opportunity is, however, less certain. Much of his work is excellent: the experiments are, for the most part, well chosen and clearly described; but after a careful perusal of his book, one's prevailing impression is that he has attempted to include too much.

A book of this kind is, of course, largely taken up with description of experimental procedure; but the space is often further occupied with matter which might, in our opinion, be left until a later stage in the student's career. Such questions as X-rays, tests for and theory of colour-blindness, interference and polarisation of light, are too large for more than the briefest notice, and might therefore just as well have been omitted altogether; especially when, to mention one instance out of many, curved mirrors are dismissed with a far too scanty discussion, and no special experimental illustrations at all. It would, in our opinion, have been better to develop further the experimental treatment of the simpler parts of physics at the expense of these more elaborate phenomena. It is only in places, however, that the work is affected by this fault; and the same may be said of an occasional laxness of expression which will probably lead to mistakes on the part of young readers where it occurs. Taken as a whole, the book forms a useful addition to the elementary text-books on practical physics.

We have noticed a few points that rather need alteration. In the figure of the apparatus for determining the heat of vapourisation of water (p. 172), the long tube connecting flask and calorimeter should be provided with a trap for the steam condensed in it. The statement in italics on p. 213, that "various bodies can be brought by friction (*i.e.* by doing work upon them) into a condition such that they attract and are attracted," is rather misleading. It is, of course, the work done in pulling the rubber and rubbed object apart which should be emphasised. On p. 337, in the figure illustrating the motions of the air in sound waves, the arrows want altering; on pp. 308 and 310, misprints of iron for ion, and ammonium for ammonia, respectively, occur; and on p. 99, in the last column the decimal point has gone astray.

The general get-up of the book is, as one would expect, excellent; and the diagrams, which are mostly by Mrs. Nichols, are very clear and well executed. We may add that the work is almost wholly non-mathematical.

The second of the two books named at the head of this notice, forms the first part of vol. iii. of the "Elementary Practical Physics" series begun in 1885 by Prof. Balfour Stewart and Mr. W. W. Haldane Gee.

With the rapid development of the teaching of physics by laboratory methods, now in progress, has arisen the

growing need of a good practical and elementary course on sound. The present work admirably supplies this need, and constitutes a worthy companion to the well-known volumes already published in the Stewart and Gee series. The author is, moreover, thoroughly familiar with the experimental side of his subject; besides being clearly and concisely written, his work is thus rendered very interesting to read.

Starting with chapters on the nature of sound and wave motion, he discusses in the following order the sonometer, resonance, determination of frequency, rods and plates, tuning forks, pipes, harmonic motion, reflection and refraction of sound, velocity of sound, Döppler's principle, musical scale, analysis of sounds, interference, beats, differential and summational tones, &c. The book ends with a useful list of workers in theoretical and experimental acoustics, with dates of birth and death.

Sound is a subject which lends itself to pretty experiments, and there is no lack of such here. To choose one instance out of many, we may refer to Expt. xc., in which the refraction of air waves in the Sondhauss experiment is imitated in water by making ripples pass over a shallow circular patch in a deeper sheet of water, and thus retarding them as the air-waves are retarded by the CO_2.

More might perhaps be made of the india-rubber cord as an illustration of the properties of stretched strings. By causing a metronome to beat at the same rate as a horizontally stretched cord, it is easy to obtain good quantitative results, while the slowness of the vibrations is a great help to unimaginative students in subsequently understanding the behaviour of stretched wires.

There is a mistake in the diagram on p. 22, where, of the two quantities plotted, one should be replaced by its reciprocal if the result is to be a straight line. On p. 105 there is a 2 omitted from the equation for t.

These are, however, trifling slips in a work for which teachers of physics cannot fail to be grateful to the author.

A. P. C.

AMERICAN GAME BIRDS.

The Gallinaceous Game Birds of North America. By D. G. Elliot. 8vo, pp. xviii + 220, illustrated. (London: Suckling and Co., 1897.)

THE author of this little volume is already so well known to naturalists from his splendid illustrated folio monographs of various groups of mammals and birds, that any work from his pen needs but little in the way of commendation. Among his monographs are two respectively devoted to the grouse and pheasants, and it is the American representatives of these groups that he now describes in a less elaborate form, and with the advantage of all the observations recorded since the publication of his larger works. The present volume is indeed the companion to the author's "North American Shore Birds," which has already been well received; and since a large number of British sportsmen now visit the States, the demand for the work ought to be considerable. Although not so good as some we have seen, the photogravures with which the work is illustrated are for the most part of a fair grade of excellence, and afford every facility for the identification of any specimen with which the naturalist or sportsman may meet.

The work commences with a general dissertation on game birds and their affinities, written in such a popular, and at the same time such exact, style, that it should prove acceptable to readers of every class. Following this is a description of the habits and characteristics of the various North American representatives of the group, which, inclusive of subspecies, total up to forty-four. A feature of the work is that the main portion of the text devoted to each form is headed solely by the popular name of the particular species or race; the technical name and detailed description coming at the end of each section. In view of the general shuffling of scientific names now taking place in all classes of animals, their relegation to a subordinate position in a popular work is by no means inadvisable; and those readers who so desire, can easily skip the technical portions altogether.

Apart from these technical descriptions, the work is written in a bright and attractive manner, the habits of the different species being noted in considerable detail, and their geographical distribution most carefully worked out. It will be a matter of satisfaction to many to learn that while certain kinds of game birds are dying out from the effects of persecution in the more settled districts, some others are gradually making their way to the wilder districts of the west, where they will meet with better chances of survival.

As many of our readers are aware, with the exception of the grouse and ptarmigan, which have a circumpolar distribution, the game birds of North America are totally distinct from those of the Old World; the pheasants, quails, and partridges of the latter being quite unknown in the former area, where their place is taken by the so-called American partridges. The author might have explained that this difference is doubtless due to the inability of either of these groups to withstand the cold of high northern latitudes which apparently prevailed at the time of a land bridge *viâ* Bering Strait. A parallel instance is afforded by the absence of hyænas and civets from America.

As regards classification, the author departs considerably from the view usually adopted in Europe. Instead of restricting the *Tetraonidæ* to the grouse and ptarmigan, he includes in that family the Old World *Perdicinæ* and the American *Odontophorinæ*, both of which are usually placed in the *Phasianidæ*. Apart from all other considerations, the circumpolar distribution of the grouse and ptarmigan renders it in the highest degree desirable that they should be kept as the sole representatives of a family differing by its distribution from all the other groups of the order.

A series of coloured papers illustrating the colour-terms employed in the text concludes this well-written and useful compendium of North American game birds.

R. L.

OUR BOOK SHELF.

L'Éclairage à l'Acétylène. Par G. Pellissier. Pp. 237. (Paris: Carré et Naud, 1897.)

IN England the discovery of calcic carbide, and the ease with which acetylene may be prepared from it, has attracted a large amount of attention; but the literature of the subject is practically restricted to a few papers read before various societies and to the returns of the

Patent Office, whereas in France the subject has been considered of sufficient importance to justify the compilation of several fairly bulky works.

Well illustrated and clearly written, M. Pellissier's volume on "L'Éclairage à l'Acétylène" will be found both useful and interesting to the large number of persons who are now taking a lively interest in the future of this new illuminant.

The work opens with a chapter on the physical and chemical properties of acetylene, and a description of the methods by which it has been made since its discovery by Edmund Davy in 1836, a valuable portion of the chapter being devoted to the dangers attributed to its use under low pressures, a consideration of which leads to the conclusion that under these conditions it is no more dangerous than coal-gas.

The question of electric furnaces is then discussed, and illustrations of the forms in use and proposed are given; and this is naturally followed by a chapter on the carbide itself and the various data obtainable as to its cost, the results obtained by the Committee of Investigation appointed by the editor of the *Progressive Age* in America being largely quoted. Such discussions, however, are of but little use, as the cost of the carbide must vary largely with the cost of the power needed to generate the electricity and the facilities for cheap carriage.

It may be taken as proved that under the conditions at present existing the carbide cannot be made at less than from 7*l*. to 10*l*. per ton in France or in England; whilst the selling price is entirely in the hands of the manufacturer, and amounts to from 16*l* to 20*l*. per ton. In treating of the methods by which acetylene can be generated from the carbide and the generators used or suggested for that purpose, the author very conveniently divides the generators into three classes: those in which acetylene is generated by allowing water to drip on carbide, those in which water is brought in contact with carbide by change of level, and finally, those in which the carbide is dropped into water.

There is not the least doubt that the last is by far the best method to employ, as the gas evolved is far purer, and dangerous rise of temperature is avoided.

The question of portable lamps, acetylene in a liquefied and compressed condition, and its solution in acetone are all dealt with, and no attempt is made to gloss over the dangers incurred directly ordinary pressures are far exceeded. The last three chapters of this little work are devoted to the subject of the conditions existing in the acetylene flame, the forms of burners for its consumption, the relative price of acetylene as an illuminant, and practical directions for its use.

The weakest part of this capital work is that in which the author, with true patriotism, attempts to prove the priority of M. Moissan in discovering the possibility of manufacturing calcic carbide in the electric furnace; whilst facts show that the Canadian, Willson, had made crystalline calcic carbide in the electric furnace, and had privately sent specimens of it to scientific friends, several months before Moissan first mentioned its accidental formation.

Atlas der Himmelskunde auf Grundlage der Ergebnisse der coelestischen Photographie. By A. v. Schweiger-Lerchenfeld. (Vienna: A. Hartleben, 1897.)

HERR VON SCHWEIGER-LERCHENFELD set himself no light task when he undertook the work of selecting and publishing the material gathered together in this beautiful atlas. A glance through the first few parts shows that no pains have been spared, either in the selection and reproduction of the photographs or in the text, to make the volume, when completed, of most absorbing interest to any one who wishes to know something outside this little earth of ours.

The aim of the compiler has been to fully illustrate by the best processes available, and to explain by accompanying appropriate text, the wonders of the universe as they have been revealed to us by means of that most valuable aid to science—photography. Herr v. Lerchenfeld has been fortunate enough, not only in obtaintaining the aid of most of the chief astronomers connected with observatories in which photography is employed, but in receiving valuable information from the most skilled instrument-makers of to-day. The result is that the atlas is full of beautiful reproductions of many of the finest photographs ever taken of celestial bodies, and the instrumental equipment of modern observatories is fully included.

It would be impossible to enumerate the many and various subjects which are here dealt with, so it must suffice to give a brief summary of the more prominent features. It may, however, be first remarked that the atlas in a completed state will contain over 50 large plates and about 135 single reproductions, the text being accompanied by no less than 500 additional illustrations. Nearly one third of the latter is devoted to a description of the various astronomical instruments now at work in the chief observatories of the world. This section is of great interest, and will be found useful, as a great amount of information is here brought together. The fine reproductions of the best lunar landscapes will be found invaluable to selenographers, as particular care has been bestowed on these to render them accurate. Stellar photography is richly and beautifully illustrated, and one really revels among the best illustrations that have yet been brought together in one volume. The plates illustrate the results of employing lenses varying from one to thirty-six inches, with periods of exposures varying from minutes to several hours.

Cometary, solar, spectroscopic and planetary photography all fall within the compiler's reach, so that a reader's desire for a good astronomical picture book is here fully satisfied.

In conclusion we may say that this atlas is well worth obtaining, if only for the illustrations themselves, and it will be found serviceable not only in observatories, but in schools and teaching centres. W. J. S. L.

Knowledge. Vol. xx. January to December 1897. Pp. xii + 304. (London: *Knowledge* Office.)

THIS well-known popular magazine of science is as good to-day as ever it was. The illustrations, especially the full-page plates, are excellent, and the articles cover a variety of scientific subjects. Special characteristics of the volume are a series of articles on the science of the Queen's Reign, and the prominence given to ornithological notes.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Physiology and the Royal Institution.

ALL interested in physiology must notice with regret the retirement of the late Fullerian Professor of Physiology from his appointment at the Royal Institution, after expiration of only one year's tenure. His resignation leaves a valuable and notable course of lectures incomplete, to the disappointment of many whom they keenly interested. His withdrawal removes in mid-career a teacher of recognised ability from a chair to which he was devoting himself with conspicuous success. Matter for regret this it seems cannot, however, be taken as matter for surprise, if I judge rightly in connecting with his resignation a letter appearing last July in your columns; there the Fullerian Professor pointed out that the practical circum-

stances attaching to the chair almost preclude possibility to treat its subject as a province of experimental science. Physiology, inseparable from chemistry and physics, could, one might have imagined, at an Institution so famous for the character of its lectures on those subjects, have been advantageously placed. That, from Prof. Waller's letter, is evidently the reverse of its present case at the Royal Institution. Not a workroom, even of the smallest size, could he obtain for conduction or preparation of his experiments. This must be a revelation to many who know the Institution as connected with the names of men. such as Davy and Faraday, who contributed by research to physiology—who, in other words, considered the chemistry and physics of living material as well as that of dead to lie within the scope of study and inquiry supported by the Institution. It is true that the Fullerian chair of Chemistry has proved fruitful in measure exceeding the productiveness of the Fullerian chair of Physiology. The latter has been declared comparatively sterile. This is regrettable; but its reason does not seem far to seek Both chairs have been held by men of high distinction; but the former has rested upon a laboratory, while the latter—so far from resting upon a laboratory—"does not possess even one small room in which to keep itself alive." Is this condition irremediable? I ask although by circumstance outside the Institution; and ask simply as one interested in the welfare of physiological science, and as a unit of a public who esteem the Institution as a place of instruction for the educated masses of a great city where at present such opportunities as the Institution offers are lamentably few.

Liverpool, December 31, 1897. CH. S. SHERRINGTON.

A Mechanical Theory of the Divining Rod.

THE review in NATURE (October 14, 1897, pp. 568, 569) of a publication relating to the "divining rod," recalls to my mind a purely mechanical theory of that rod, which was given me years ago by a friend.

This theory has been repeatedly tested by me and shown to be correct in the presence of my classes. The process is exceedingly simple. Take any forked twig of a reasonably tough fibre in the clenched hands with the palms upward. The ends of the limbs forming the twig fork should enter the closed fists on the exterior side of each fist, *i.e.* on the two sides of the clenched hands furthest from each other.

When a twig is grasped in this position it will remain stationary if held loosely, or with only a moderately firm grasp; but the moment the grasp is tightened, the pressure on the branches will force the end of the twig to bend downwards. The harder the grip the more it must curve.

The curvature of the twig is mechanically caused by the pressure of the hands forcing the limbs to assume a bent and twisted position; or the force that causes the forked limb to turn downwards is furnished by muscles of the hands, and not from any other cause.

The whole secret of the "divining rod" seems to reside in its position in the hands of the operator, and in his voluntarily or involuntarily increasing the closeness of his grasp on the two ends of the branches forming the fork.

If the above conditions are fulfilled the twig will always bend downwards—water or no water, mineral or no mineral; any one can be an operator, and any material can be used for the instrument, provided the limbs forming the fork are sufficiently tough and flexible.

It can be easily understood how an ignorant operator may deceive himself, and be perfectly honest in supposing that some occult force, and not his hands, causes the fork to curve downwards. M. E. WADSWORTH.

Michigan College of Mines, Houghton,
Michigan, December 8, 1897.

Growth of the Tubercle Bacillus at a Low Temperature.

A BROTH culture of the tubercle bacillus a month old was filtered through a sterilised Berkfeld filter; the filtrate was ascertained to be sterile; it was then sown with a trace of *B. tuberculosis* and incubated at a temperature varying slightly between 18°–20° C., but never higher than 20°.

The bacillus developed well, but not so rapidly as at the customary temperature, *i.e.* 37·8° C.; the growth had not the usual flocculent appearance, but was granular.

Microscopically the organism was unchanged.

London, December 20, 1897. F. J. REID.

THE STORY OF GLOUCESTER.

1979 cases of small-pox, 434 deaths; or a mortality of 21·9 per cent. during a period of thirteen months.

	Cases.	Deaths.	Percentage mortality.
Previously vaccinated ...	1211	120	9·8
Unvaccinated	768	314	40·8
	1979	434	

SUCH, in brief, is the story told by Dr. Sidney Coupland in his Report to the Royal Commission on Vaccination on the outbreak of small-pox in the city of Gloucester in 1895–96.

These figures, in all their baldness, convey a lesson such as no long garnished account can accentuate or emphasise; but in Dr. Coupland's Report a number of most interesting facts and statistics have been brought together, which will form the basis of many future reports and arguments.

One of the most interesting points brought out, apart from the mortality, was the proportion of severe and mild cases in vaccinated and unvaccinated patients. Of those vaccinated in infancy, there suffered from—

	Per cent.	
Malignant small pox	2·4	of the whole of those attacked.
Confluent ,,	19·1	,, ,,
Coherent ,,	9·6	,, ,,
Discrete ,,	28·7	,, ,,
Mild ,,	40·0	,, ,,

When we come to those who are said to have been vaccinated, but of which there is no very strong evidence, we find:—

	Per cent.	
Malignant small-pox	17·5	of the whole of those attacked.
Confluent ,,	52·5	,, ,,
Coherent ,,	10·0	,, ,,
Discrete ,,	12·5	,, ,,
Mild ,,	7·5	,, ,,

Being a marked rise in malignant and a great fall in mild cases.

Amongst the unvaccinated the proportion of severity of attacks at all ages was:—

	Per cent.
Malignant small-pox	5·0
Confluent ,, ...	72·3
Coherent ,, ...	10·3
Discrete ,, ...	8·7
Mild ,, ...	3·6

Showing a very high percentage, indeed, of the severe type of case.

These figures are given in full because they afford evidence, quite apart from the mortality, of the enormous influence that vaccination exerts on the course of an attack of small-pox.

The Gloucester epidemic appears to have differed from almost every other recent outbreak of small-pox in the fact that its incidence was especially heavy on infants and young children. Below one year the proportion of deaths was no fewer than 14 per cent. of the whole, whilst at ages from 1 to 10 years it was exceedingly heavy—50·4 per cent. This, of course, was accompanied by a corresponding diminution in the proportion of deaths at later years; and from 10 to 30 years the proportion had fallen to 12·6 per cent., though from 30 years and upwards (the effect of early vaccination having worn off to some extent) it had again risen to 22·7. When these figures are compared with the earlier outbreak of 1873-75 in Gloucester and with the Dewsbury and Leicester outbreaks, it is found that the proportion of deaths amongst children is exceptionally high. It was noticed, too, that the disease spread amongst these children with enormous rapidity, and that it occurred amongst them in an exceptionally severe type, both as regards the proportion of malignant cases and the height of the mortality.

It is certainly not going beyond the facts of the case to state that the above-mentioned characteristics of this epidemic must in great measure be attributed to the large number of unvaccinated children who were in attendance at school, and who were thus not only extremely susceptible to the attacks of small-pox, but were in a position to disseminate the disease, though in a milder form, amongst those who had been vaccinated. That is, the neglect to have the children vaccinated left them in a condition in which they would readily take small-pox just at the time when their surroundings were of such a nature that everything was favourable to their taking the disease from one another, and in turn passing it on to those with whom they daily came in contact; with the result, as Dr. Coupland points out, that one in twenty of the whole population of Gloucester were struck down with small-pox. Indeed, he goes so far as to say that, "viewing the subject with as impartial a mind as I can, the conviction is forced upon me that Gloucester would not have suffered as it did had its child population been vaccinated." It was this want of vaccination, and the impossibility of maintaining effective isolation of the attacked, that allowed of the abnormally rapid spread of the disease after it has once obtained a firm hold in the city.

If there was one more important feature than the rapidity of the outbreak, it was that the epidemic faded away—for that is the only term that can be applied—so abruptly. Numerous explanations have been put forward to account for this, but the only factor that appears to have had any real determining influence in bringing about this abrupt cessation of the disease, was the universal adoption of re-vaccination after small-pox had already obtained its firm foothold in the city.

That Dr. Coupland is not going beyond his brief when he holds that this high child mortality was due to the unvaccinated condition of many of the children, is evident from certain statistics which he gives concerning 3546 cases. Of these only 85, or 2·5 per cent., were in vaccinated children below the age of ten years; and amongst these 85 cases there was only a single death.

These were all cases recorded in papers and reports which had come directly under Dr. Coupland's personal observation during his investigations into the outbreaks of small-pox in Dewsbury, Manchester, Oldham, Leeds, Halifax, Bradford and Leicester. In the Dewsbury, Leicester, and Gloucester outbreaks the number of children that had not been vaccinated was very high indeed. Now, taking Dewsbury, where the proportion was lowest, the number of deaths to attacks was as one to nine; in Leicester, as one to seventeen; and in Gloucester—where the proportion of unvaccinated was highest of all—the proportion of deaths to attacks was as one to four and a half, although the attacks in Gloucester were nearly 2000 (1979), in Leicester 357, and in Dewsbury 1029.

Comparing these three outbreaks, and bearing in mind the proportion of unvaccinated as above, we find that the proportion of the whole number attacked under ten years was in Dewsbury 21·7 per cent., in Leicester 30·5 per cent., and in Gloucester 35·6 per cent.; the fatality of this class in the three cases being Dewsbury 25·4 per cent., Leicester 13·7 per cent., and Gloucester 39·6 per cent.

As affording evidence of the disproportionate incidence of the disease upon young children, to which reference has already been made, it may be stated that 706 of the whole number attacked, or 35·7 per cent., were under ten years of age; whilst of the 434 fatal cases 280, or 64·5 per cent., occurred in this age period. Of these 706 only 26 had been vaccinated before the epidemic broke out, whilst of the remainder, 80 were undergoing vaccination when attacked with small-pox, the operation having been performed within fourteen days of the onset of the disease. It will thus be seen that only 4 per cent. of those attacked at this age period had been vaccinated, although a much larger proportion of vaccinated had been exposed to infection. It is found that of those exposed to infection, in households invaded by small-pox, of the vaccinated class 3386, and of the unvaccinated class 1475, there were attacked with small-pox—of the vaccinated class 1028, or 30·3 per cent.; whilst of the unvaccinated class 689, or 46·6 per cent., became infected.

It has already been indicated that amongst the unvaccinated at Gloucester the type of the disease was much more severe than in the vaccinated class. For purposes of comparison it may be shown that in Gloucester, where, as we have already seen, the number of unvaccinated children was very high—much higher than in Dewsbury or Leicester—the type of the disease over all was much more severe than at either Dewsbury or Leicester, and still more so than in many of the other recent outbreaks. Taking the severe type as including malignant and confluent cases, and the milder type as including coherent, discrete and mild cases, we find that in Dewsbury 26·5 per cent. of all attacks were of a more severe type, in Leicester 26·8 per cent., and in Gloucester 43·1 per cent.; whilst the mild type accounted for 27·5 per cent. in Dewsbury, 35·5 in Leicester, and only 25·5 in Gloucester.

If we now take out Dr. Coupland's figures as regards attacks of small-pox affecting vaccinated and unvaccinated patients, we find that in Dewsbury 64·3 per cent. of the whole number, with a mortality of 2·7 per cent., were vaccinated; in Leicester 55·8 per cent., with a mortality of 1 per cent.; in Gloucester 61·2 per cent., with a mortality of 9·8 per cent. These figures compare very favourably with the cases of deaths in the unvaccinated class. There were 35·7 per cent. of the whole cases that had not been vaccinated in the Dewsbury Union, and amongst these there was a fatality of 25 per cent.; in Leicester 44·3 per cent. of the cases were unvaccinated, with a death-rate of 12 per cent; whilst in Gloucester 38·8 per cent. of the cases had not been vaccinated, and amongst these there was a death-rate of 40·8 per cent. It will thus be seen that the lowest death-rate in the unvaccinated class (12 per cent. at Leicester) was considerably higher than the highest death-rate in the vaccinated class (Gloucester, 9·8 per cent). It must be borne in mind, of course, that even in the worst vaccinated districts the proportion of unvaccinated to vaccinated persons is very much lower than the proportion of vaccinated small-pox cases to non-vaccinated cases, so that we not only have an enormously greater mortality amongst those attacked, but the percentage of attacks is also considerably higher.

Any one who goes carefully and with unbiassed mind into the statistics collected by Dr. Coupland must inevitably come to the conclusion that, although the disease was spread in schools owing to the simultaneous infection of school children from cases unrecognised by, or unknown to, the authorities until the area of infection had been considerably widened; although after the sudden outbreak of small-pox it became, first, a difficult—and eventually an impossible—task to isolate the patients attacked, and to treat even a small proportion in hospital; and although insanitary surroundings and a certain amount of overcrowding may have played some part in spreading the disease, we must ultimately fall back upon the neglect of a large number of parents to see to the vaccination of their children for an adequate explanation of the extent of the epidemic and the rapidity of its extension. The utter futility of all ordinary measures recommended for the limitation of the spread of small-pox, apart from vaccination, is only too clearly brought out.

Hospital accommodation and isolation are usually insisted upon, by those who do not believe in vaccination,

as being sufficient to prevent any outbreak of small-pox assuming serious epidemic proportions. Now, what did Dr. Coupland find at Gloucester? That a few slight or mild cases in 1895 were followed by a severe epidemic extending from February to April 1896, in which not only was there an increase in the numbers attacked, but there was also an undue proportion of cases of a severe type accompanied by a high rate of mortality. As showing how in a community with a large proportion of unvaccinated children the disease may spread rapidly, we have the fact that there was an "almost simultaneous invasion of many homes through children who were infected whilst attending certain of the public elementary schools." As a result of this sudden outbreak it became impossible to provide hospital accommodation, and, ultimately, all attempts at isolation, of even a modified form, had to be abandoned as utterly impracticable. As a result of the crowding of the hospitals, and of the removal of the most severe cases to them, the hospital mortality was comparatively high, and the friends of the patients would soon not permit of the removal of these patients to hospitals; this, of course, resulting in an utter break-down of the system of isolation.

Dr. Coupland sums up in the following exceedingly striking passages. He says: "There is no escape from the conclusion that the heightened mortality and the severity of the epidemic were greatly due to so large a proportion of unvaccinated children being attacked; for (*a*) the case mortality under ten years of age was 39·6 per cent., whilst amongst the vaccinated it was only 3·9 per cent., leaving a mortality amongst the unvaccinated of 41 per cent. . . . (*b*) The disparity is quite as marked when the type of the attack is contrasted, for of 507 cases of *severe* attacks [malignant, confluent, indeterminate] there actually occur only three amongst the vaccinated." From these and other considerations it follows that in the Gloucester epidemic "the severity of the disease, its high mortality, and its propagation were influenced and promoted by the unduly large proportion of unvaccinated children who were exposed to infection and who were infected."

To whatever figures or tables we turn, the effect of them is always the same. They tell the same story — vaccination protects; unvaccinated children are left susceptible to the attacks of the disease, and they not only take the disease more readily, but they take it in a more dangerous and fatal form, and, in most cases at any rate, are a source of greater danger to those with whom they may come, directly or indirectly, in contact. Isolation, good hospital accommodation, and favourable sanitary conditions are useful in the treatment of small-pox in a vaccinated community; but once let small-pox find its way into an unvaccinated community, the inefficiency of these "accessory" measures, when used alone, are demonstrated with the most absolute clearness; and if Gloucester has one lesson more than another to teach, it is that Jenner, by his advocacy of vaccination, did more to limit the spread of small-pox than have all the sanitarians of the century. Small-pox undoubtedly does not come under the class of diseases that can be held in check by ordinary sanitary measures; these, no doubt, are contributory, but without vaccination they can never be depended upon as being fully effective.

CANADIAN GEOGRAPHY.

THE reissue of "Stanford's Compendium" now includes Australia and the Pacific Islands in two volumes by separate authors, Asia in two volumes and Africa in two volumes by the same author, and vol. i. of North America.[1] The new issue is in many ways vastly superior to the old; the cramping influence of the foreign original has disappeared, the illustrations have greatly improved, and, linked by the general title, each of the volumes forms a separate and original work of distinct value. So good, indeed, has "Stanford's Compendium" become, that it may now be allowable to subject one of its volumes to criticism of a more searching kind than would have been justified formerly. Then any attempt to form a library of solid geographical works in the English language was worthy of commendation; now it is possible to set up a higher standard, and it is reasonable to look for those excellencies of grasp and arrangement which one naturally expects in, let us say, a German work of similar scope.

The morphological unity of the continent is one of the fundamental facts of modern geography. The continent is the natural unit which must be considered in its entirety, with parts subordinated to the whole, and with functional activities of a distinctive kind. It is capable of subdivision, either naturally into regions or artificially into countries, and of aggregation with other continents to form the whole land-surface. The dominant lines of the continent—its axial mountain systems—determine

FIG. 1.—The Bore, Petitcodiak River, Moncton, New Brunswick, August 8, 1892. Height, 5 feet 4 inches.

the primitive slopes of the land, and the development of the river systems, subject to the continuous workings of secular uplift or depression and the accumulation of sediment. The resulting configuration modifies the climate as dependent on latitude, and leads to the formation of areas of moderate and of extreme temperature, of high rainfall and of aridity. Climate reacts on vegetation, and vegetation and climate together influence the distribution of animals; and all these varieties of feature and function are framed in the continent. Thus up to the appearance of man a geographical description must be based on the continent as a unit if it is to be really simple and comprehensible. With the advent of man complications arise, but the guiding influence of the main features of continental relief and surface-covering is still to be traced. The deep inlets tempt the adventurous stranger to penetrate the continent, the easy waterways lure him into the interior, where products of forest and plain supply an adequate inducement to remain or to return. In time groups of people settle down in habitats more or less distinctly defined by natural features—different tribes frequent the river, the lake, the forest, the plain, the mountain valley, the indented ocean shore.

[1] "Stanford's Compendium of Geography and Travel" (new issue). North America. By S. E. Dawson. Vol. i. Canada and Newfoundland. Maps and illustrations. (London: Edward Stanford, 1897.)

Consequent pressure of population or change in the availability of resources sets up migratory movements along natural lines dictated by land-form, water-flow, and soil-covering; conquest and delimitation ensue, and the straight boundary lines of the map, which come last, are, after all, natural relations to geographical facts associated with the whole body of the earth itself and its rotation. The grouping of dwelling-places around certain centres leading to the origin of towns may also, as a rule, be explained by geographical considerations.

Of the six continents which are usually recognised two stand out from the rest, distinguished by the simplicity of their great features and the clearness of the interdependence of the various relationships. These are North and South America, either of which forms an ideal subject for a geographical monograph.

We have mentioned the superiority of the new issue of "Stanford's Compendium" over the old; but there is one point of distinct inferiority. The old issue retained some traces of the original design, giving it a certain unity; the new is not so much a compendium as a series of separate works. Dr. S. E. Dawson's "North America, Vol. i.," is not, strictly speaking, the first part of a geographical description of North America. It is the description of the Dominion of Canada and Newfoundland, written not from the standpoint of a geographer, but from that of an imperialist British subject and patriotic Canadian. The author infuses warm colour into his narrative, which, gratifying as it must be to the sentiments of the people of the British Empire, does not enhance the value of the work as a scientific treatise. Dr. S. E. Dawson is obviously not himself a geographer —his strength lies in his treatment of history. Having expressed our view as to what a geographical treatise on a continent should be, we need only add that "North America, Vol. i.," is written without regard to the guiding principles of geographical science.

We have seldom, if ever, read more satisfying or more graceful renderings of history than the chapters of this book dealing with the discovery, exploration and occupying of the provinces of the Dominion. Unexpected comparisons and contrasts of the aptest kind with the course of history in other lands and other times continually delight the reader's mind and illuminate the story. But when from history the author enters geography the wheels seem to drop from his chariot, and he drives heavily. One could imagine that he wrote with effort, perhaps even with distaste. His comparisons lose point, and are sometimes inaccurate. Canada is not, as stated on p. 29, "above all others the land of abundance of waters." Finland or Sweden would, we believe. correspond better—certainly as well—to the definition, If any great river is to be celebrated for the length of its tributaries it should surely be the Amazon, the Congo, the Mississippi, rather than the St. Lawrence (p. 34). As to climate, we dispute the suggestion that tobacco cannot be grown in England (p. 47), and we must remember the success of Lord Bute's wine-making from grapes grown in the open air at Cardiff. The treatment of climate is otherwise not fully satisfactory. While no attempt is made to deny that the Canadian winter is cold, the author seems more concerned to combat what he believes to be the average Englishman's exaggerated ideas on the subject than to describe the actual conditions. With regard to the French of Quebec (p. 295), which some people seem to have called a *patois*, the author observes: "English is not spoken in the same way over all the United Kingdom, but no one speaks of a Dublin or an Aberdeen *patois*, or for that matter of a London *patois*." We can assure him that some people do speak of the *dialect* (a word as displeasing as *patois*) of these parts, and many authors, with an eye to popularity, delight to exaggerate rather than minimise such differences. The tunnel at Sarnia, 6025 feet long (p. 391), cannot be termed "one of the greatest in the world," unless the standard of greatness is put very low, and the number of great tunnels made very large.

FIG. 2.—The Prairie, Manitoba.

These are instances which do not seriously detract from the value of the book to the general reader; but Canada is so great, and its natural resources are so vast,

that comparisons of the kind would be quite unnecessary even if they were sound. A somewhat serious defect is the occasional imperfect revision, giving rise in the non-historical sections to repetition and to vague or even inaccurate phrases, such as the description of a boundary as a "perpendicular line" (p. 453) when a meridian is meant. We note a few omissions: nothing appears to be said of the extreme danger of the Magdalen Islands, in the Gulf of St. Lawrence, to shipping; of the devastation of the forests in many parts of the country by fire; or of the high "benches" or river-terraces of British Columbia, which to a geographer form, perhaps, the most striking feature of that wonderful province.

We must, however, make it perfectly distinct that so far as the matter in this book is concerned the omissions are trifling, and the selection of facts most judicious. Dr. S. E. Dawson handles themes regarding which a Canadian might justly be excused if he were to indulge in a little exaggeration; and if the writer of this notice had never seen Canada, he would have supposed that there was some exaggeration here. But a journey from Quebec to Nanaimo, with visits to various points in the Kootenay and on the shores of the Great Lakes, has convinced the critic that in every estimate of natural wealth, and in every appreciation of the law-abiding enterprise of the Canadian people, the author has under-stated rather than over-stated the facts. If a passing tourist of no very imperialistic tendencies felt the pride of a citizen of the British Empire rising within him with each mile of the magnificent railway which is the benefactor of every province in the Dominion, he cannot but be surprised at the moderation of tone adopted by an heir of that fair heritage in writing an account of its actual and potential greatness.

Yet the book is not planned in harmony with the principles of geography, and that, after all, is the aspect to which attention must be called in the pages of a scientific journal. The illustrations are good, and characteristic, as the specimens here reproduced show, and the maps very fair, although not so numerous or so well selected as we could wish. There are practically no physical maps, for the sketch of the Archæan nucleus on p. 24 is a mere diagram, and the "Meteorological Map" shows only mean annual isotherms, which give no clue to the climate, and rainfall areas, which are difficult to grasp as a whole. There is certainly no lack of cartographic material in Ottawa, as the beautiful physical maps in the "Handbook of Canada," issued in connection with the recent meeting of the British Association, prove. HUGH ROBERT MILL.

THOMAS JEFFERY PARKER, F.R.S.

THOMAS JEFFERY PARKER, whose death on November 7 last we chronicled on December 23, was the eldest son of the late William Kitchen Parker, F.R.S., the world-renowned comparative osteologist. He was born at 124 Tachbrook Street, London, S.W., on October 17, 1850, and received his elementary education at Clarendon House School in the Kennington Road, under Dr. C. H. Pinches. In 1868 he entered the Royal School of Mines as a student, taking the Associateship in Geology in 1871, together with the Edward Forbes medal and prize of books for distinction in biology. Thus qualified, he became for a short period science master at Bramham College, Yorkshire; but in 1872, on a special invitation by Huxley, he returned to London to fill the office of demonstrator under him at South Kensington, and that he held until his appointment in 1880 to the chair of Biology in the University of Otago, Dunedin, N.Z. During his period of demonstratorship he also held the office of Lecturer in Biology in Bedford College, London, and officiated as examiner in Zoology and Botany to the University of Aberdeen and as an assistant examiner in Physiology to the Science and Art Department. Parker was of a distinctly artistic temperament, æsthetic, musical, well-read, and possessed of marked literary ability, which asserted itself to a conspicuous degree in his little book upon his father, published in 1893, an altogether ideal filial biography—a good work by a good man. He early cultivated the critical faculty, as a direct result of the study of Matthew Arnold, whose writings he knew by heart; and with the great power of application and strength of character which he displayed during active work, there can be little doubt that he would have succeeded in any of the higher walks of life. He would have made a mark in literature, and as a caricaturist draughtsman would have achieved renown; and there is little doubt that his choice of biology for his life's calling was largely due to the charm and influence of his father's career and to his early association with Huxley, who knew him from childhood and became the object of his veneration. Both as a teacher and investigator Parker was untiring and thoroughly trustworthy. Though easily roused to enthusiasm he rarely became excited, and his cool deliberation came welcomely to the aid of the troubled student, to whom if in earnest his attention knew no bounds. His published papers exceed forty in number, and though mostly zoological they embody important work and observations in botany. Parker was the first appointed of the little band of biological professors sent out from home in the '80's, who now fill the Australian and Novozelandian chairs, and his second paper published in New Zealand dealt with a new species of Holothurian (*Chirodota Dunediensis*), as it were in anticipation of the later determination by himself and his contemporaries at the Antipodes to devote their attention to the indigenous fauna, rather than to refinements in histology and the like which could be better studied at home. The work already achieved by this body of investigators, with Parker at their head, is now monumental, and none of it more so than Parker's monographs "On the Structure and Development of Apteryx" and "On the Cranial Osteology, Classification, and Phylogeny of the Dinornithidæ," in themselves sufficient to have established his reputation. His lesser writings, although they deal with a wide range of subjects, show interesting signs of continuity of ideas, as for example in the association of his early observations on the stridulating organ of *Palinurus*, made in London in 1878, with those upon the structure of the head in certain species of the genus (one of the most charming of his shorter papers), made on the voyage to New Zealand, and upon the myology of *P. Edwardsii*, which, in co-operation with his pupil Miss Josephine Gordon Rich (now Mrs. W. A. Haswell), he in 1893 contributed to the Macleay Memorial volume. And the same may be said of his work on the blood-vascular system of the Plagiostomi. Soon after his arrival at the Antipodes, Parker instituted a series of "Studies in Biology for New Zealand Students," and chiefly with the aid of his pupils, these have been continued, either in their original form or in that of theses for the higher degrees of the University of New Zealand, as contributions to the publications of the Museum and Geological Survey Department of that colony. Botanical as well as zoological topics were thus taken in hand, the series, like that of a companion set of "Notes from the Otago University Museum," which he from time to time contributed to the pages of NATURE, containing important observations of general biological interest. Of Parker's books, it is sufficient to recall his "Lessons in Elementary Biology," now in its third edition and recently translated into German, undoubtedly the most important and trustworthy work for the elementary student which has appeared since Huxley and Martin's epoch-marking "Practical Instruction in Elementary Biology," published in 1875. Parker's book, in sharp contrast to his previous "Zootomy," which is

a severely didactic and somewhat uneven laboratory treatise, is a book for the study, beautifully balanced and poetic in idea. It has a charm peculiarly its own, and to ponder over it is to appreciate to the full the honest, loving, sympathetic temperament of its author, and the conviction which he was prone to express that in the progress of scientific education there lies the panacea for most human ills, mental and corporeal. Great though the merits of these books, Parker five years ago essayed a more formidable task, in the resolve to prepare in conjunction with his friend Prof. W. A. Haswell, F.R.S., of the Sydney University, a general text-book of zoology. This work of 1400 pages, in two volumes, as recently announced in NATURE, will be noteworthy for the large number and excellence of its original illustrations; and from a passing knowledge of its contents, I am of opinion that it will do much towards relieving English text-book writers of the opprobrium begotten of a too frequent content with mere translation and continental methods. And when we consider that Parker was not spared to see this great work in circulation, it is heartrending to relate that, though ailing and weak, he had since arranged with his co-author and publishers for the production of a shorter text-book to be based upon it, and had prepared the preliminary pages of yet another elementary treatise to have been entitled "Biology for Beginners," while as a next subject of research he had begun to work out, in conjunction with Mr. J. P. Hill, Demonstrator of Biology in the Sydney University, a series of Emeu chicks, including those collected by Prof. R. Semon during his expedition into the Australian Bush. The thoroughness of Parker's best work was its most distinctive character, and when tempted to generalise he always did so with extreme caution and consideration for others, fairly presenting all sides of an argument. As he remarked of himself with characteristic modesty, in a letter written in 1894 commenting upon his chances of securing a chair of Zoology at home then vacant, "I don't profess to be brilliant, but I am vain enough to think that I have the gift of exposition and can do a straightforward research so long as it does not involve anything about the inheritance of acquired characters." Far-reaching generalisation and random rhetoric had no charm for him, nor was he tempted into over-ambition and haste so oft productive of slip-shod and ill-conditioned results. As a writer and lecturer he was always logical, cautious, temperate, content could he but spread, extend, and help systematise our knowledge of observed facts, convinced that if this be done properly their ultimate teachings become self-evident. His work is of that order which marks the growth of real knowledge and the consequent bettering of mankind; and the thought that there has thus early passed from the ranks one so good and earnest, so well fitted by nature for the responsible task of training the young and susceptible, fills us with sorrow.

Parker matriculated at the London University in June 1868, and passed the Intermediate Science Examination in 1877 and the final B.Sc. in 1878, while the D.Sc. was but a matter of formal application *in absentia* in 1892. He was in 1888 elected a Fellow of the Royal Society, and in 1880 an Associate of the Linnean Society of London, resigning the Associateship for the Fellowship of the latter but a short time before his death. He was an active member of the New Zealand Institute, to which he communicated several papers, and he became in turn Secretary and President of its Otago branch. Before these bodies and elsewhere in New Zealand he delivered addresses which will linger in the memory of his hearers and those who have read them. There may be especially mentioned an address delivered before the Otago University Debating Society on September 17, 1892, upon "the weak point in our university system," in reality an eloquent appeal for post-graduate study. Proceeding to classify an average assemblage of students into "the able, the mediocre, and the stupid," he remarked that "the only duty of members of the university towards the third class appeared to be that of imposing a sufficiently severe entrance examination to keep them from wasting their own time and their parents' money, in the vain attempt to train to purely intellectual pursuits an organism which nature intended to make its way by virtue of muscle and mother wit." A more ingenious defence of an examination system could hardly be imagined. It is preceded by the shrewd remark that "the republic of science and letters is an aristocratic, not a democratic republic." Parker was evidently of opinion that what the world terms breeding and feeding count for a great deal in the end, and the whole context of his address is apposite to the share he took in the work of organisation of the University of New Zealand, which led at least to a humanising of its syllabus in biology. And for any one desirous of a knowledge of Parker at his best in a popular function, a speech delivered on the occasion of the prize-giving at the Otago Boys High School on December 13, 1894, may be recommended, as a perfect example of the kind of thing appropriate to such an occasion, so oft provocative of the mere "airy nothing." Parker was, further, a Corresponding Member of the Zoological Society of London and of the Linnean Society of New South Wales, a Member of the Imperial Society of Naturalists of Moscow, and we believe he was President-elect of the Biological Section of the Australasian Association for the Advancement of Science for the present year. He was also a Fellow of the Royal Microscopical Society; and, ever ready to help in a good work, he became one of the original assistant editors who, under the generous leadership of Frank Crisp, in 1879 elevated the Society's Journal to its present important status.

The key-note of Parker's life-work is his connection with Huxley, and in testimony to his devotion to his great chief ("the General," as he loved to call him) there remains the delightful dedication of his "Lessons in Elementary Biology." Parker entered Huxley's service as Demonstrator in Biology at South Kensington in 1872, immediately after the conclusion of the memorable course of instruction there given, now historical as having marked the introduction of rational methods into the teaching of natural science. In the conduct of that course Huxley, as is well known, secured the aid of leading British biologists of the time. It was, however, reserved for Parker to fill the more important *rôle* of lieutenant in the development of the Huxleian system and to assist in carrying it beyond the experimental stage. At the time of his appointment laboratory appliances were lacking, and a practical teaching museum based on the type-system was a desideratum. Under instructions to supply these needs, Parker in due course entered upon the task with a will, his only materials a free-hand and an early set of proofs of Huxley and Martin's "Elementary Biology" (with the final revision of which he was largely entrusted, since the junior author was leaving for Baltimore), and in carrying the task to a successful issue he founded the first practical biological museum or teaching-collection on the now generally adopted type-system, the prototype of all those subsequently established at home and abroad, in some cases even to the measurements of the furniture. The Huxleian method of laboratory instruction in the course of its development at headquarters has witnessed no change on the zoological side at all comparable to the inversion in the order of the work originally prescribed—*i.e.* the substitution of the anatomy of a vertebrate for the microscopic examination of a unicellular organism as the opening study, and this we owe entirely to Parker. As one privileged at the time to play a minor part, I well recall the determination in Parker's mind that the change

was desirable, and in Huxley's that it was not. Again and again did Parker appeal in vain, until at last, on the morning of October 2, 1878, he triumphed. Dyer and Vines were Parker's more immediate associates in the early work of development of the Huxleian laboratory-system; and among the persons who studied under him as it progressed now occupying prominent positions in the biological world, may be named F. E. Beddard, A. G. Bourne, G. C. Crick, J. J. Fletcher, Patrick Geddes, Angelo Heilprin, C. H. Hurst, C. Lloyd-Morgan, Daniel Morris, R. D. Oldham, H. F. Osborn, W. B. Scott, T. W. Shore, Oldfield Thomas, and H. Marshall Ward. Parker's first paper ("On the Stomach of the Fresh-Water Crayfish") and his first book ("Zootomy") were alike a direct outcome of the undertaking, and the scheme for his "Lessons in Elementary Biology," formulated while still he was in London, was similarly begotten of his experience during its development, which oft formed the topic of conversation as he and I in the late '70's sat working side by side. Nor must it be forgotten that Parker rendered Huxley commendable aid in the production of his wonderful book on "The Crayfish." I venture to think that in recognition of all this Parker has established a claim to distinction in connection with the educational work of his great master second to that of none other; and when it is remembered that the unparalleled activity among botanists and zoologists during the last two decades has rendered it impossible for one man to efficiently teach the two subjects from a professorial chair, in the manner originally laid down under the Huxleian dispensation, Parker's name will occupy a unique position in the history of this, as that of the only man prominently associated with its inception who taught both subjects to the end of his career.

To the task of founding the Huxleian teaching-collection, moreover, is due Parker's interest in the work of the preparator, which led to his being the first person to successfully prepare and mount in a condition fit for prolonged display cartilaginous skeletons in a dry state. Under Parker's curatorship the Otago University Museum advanced by leaps and bounds, and while to his reputation as a teacher and investigator he thus added distinction as a conservator and administrator in zoology, he attained also a reputation in botany both as a manipulator and discoverer. He came upon the botanical platform at the time when Alfred Bennett and Dyer were at work upon the English translation of the third edition of Sachs's monumental "Lehrbuch der Botanik," and when the methods of that great man, already introduced into Britain by McNab, were by these botanists and their associates becoming established. For Parker, however, carrot-drill had little charm, while to his æsthetic nature glycerine and gold-size were messy and distasteful. He was at the time repeating the work of Nicholas Kleinenberg on *Hydra*, busy with osmic acid and cocoa-butter, and the well-known results of his labours led him to apply the method to the treatment of plant tissues, with the result that through a short paper communicated to the Royal Microscopical Society in March 1879, he ranks as one of the first to apply the modern dry methods of micro-chemical technique to vegetable histology. As a discoverer in botany he will remain memorable for having first directed attention to the existence of sieve-tubes in the marine algæ (*Macrocystis*) in a short communication to the *Transactions* of the New Zealand Institute for 1881.

Truly is his a great record, worthy his noble character and his association with a Huxley! but while the world will cherish his memory for that which he achieved, those who knew him feel that by his death something more than a link with the historic past has gone, and that they have lost a true friend, a noble man, an example. In the autumn of 1892 Parker came home on a visit. Soon after his return his wife died, and this event probably helped to bring on an illness which showed itself formidably about two years ago. Recurrent attacks of influenza, the last of which rendered him prostrate for three months, told severely upon his health and strength; but despite all, following the example of his beloved father, he worked on whenever he could, patient under suffering and affliction the like of which has killed many a man, beautiful in his unselfishness and lack of ostentation, loving, and sympathetic. On October 26 last, he had recovered sufficiently to start on a journey of some forty miles to visit a friend at Shag Valley, in company with his eldest sister, who for several years had lovingly shared his anxieties and administered to the needs of his three boys. While half-way onwards he became so prostrate that a halt was necessary, his friends deeming it advisable to take him towards home again. He reached only as far as Warrington, where he became weaker and comatose, and passed peaceable away on Sunday, November 7, at one a.m. He was buried there two days later, in the presence of sorrowing friends, a few among the many by whom he was universally beloved.

G. B. HOWES.

NOTES.

FEW men of science appear in the list of New Year honours. The honour of Knighthood has been conferred upon Prof. George Brown, C.B., Consulting Veterinary Surgeon to the Board of Agriculture; Mr. Ernest Clarke, Secretary to the Royal Agricultural Society; Dr. John Struthers, late President of the Royal College of Surgeons of Edinburgh; and Dr. John Hatty Tuke, President of the Royal College of Physicians of Edinburgh. Prof. Gardiner, Dean of the Faculty of Medicine, Glasgow University, has been promoted to be Knight Commander of the Order of the Bath (K.C.B.), and Prof. D'Arcy Thompson, British delegate at the recent Conference on the Bering Sea Fisheries, has been appointed a Companion of the same Order (C.B.). Mr. James Dredge, one of the editors of *Engineering*, has been made a Companion of the Order of St. Michael and St. George (C.M.G.), for services in connection with the Brussels Exhibition; and Major R. H. Brown, of the Egyptian Irrigation Department, has been given the same honour.

MR. ALEXANDER AGASSIZ, as we learn from his recently issued report on the Museum of Comparative Zoology at Harvard College, U.S.A., for the past year, has planned to pass the greater part of the present winter in studying the coral reefs of the Fiji Islands. He will be accompanied by Dr. Woodworth and Dr. Mayer as assistants. The steamer *Yaralla* has been chartered in Sydney for the expedition. In addition to the usual apparatus, for photographic purposes, for sounding and dredging, and for pelagic work, Prof. Agassiz takes with him a complete diamond-drill outfit, and hopes to find a suitable locality for boring on the rim of one of the atolls of the Fijis. The boring machinery will be in charge of an expert sent by the Sullivan Machine Company, from whom the machinery is obtained. The Directors of the Bache Fund have made a large grant towards the expenses of this boring experiment.

THE Sydney meeting of the Australasian Association for the Advancement of Science opens to day, under the presidency of Prof. A. Liversidge, F.R.S. A large number of papers are down for reading before the various sections, and we hope to give some account of them later. The evening lectures are by Prof. W. Baldwin Spencer, on "The Centre of Australia"; Sir James Hector, K.C.M.G., F.R.S., on "Antarctica and the Islands of the Far South"; and Prof. R. Threlfall and Mr. J. A. Pollock, on "Electric Signalling without Wires."

WE regret to announce the death of Major-General Edward Mounier Boxer, F.R.S., for many years Superintendent of the

Royal Laboratory at Woolwich. General Boxer was elected a Fellow of the Royal Society so long ago as 1858.

THE deaths are announced of Mr. Arthur Kammermann, astronomer at the Geneva Observatory; Dr. Eugen Zintgraff, African explorer; and Dr. Max Graf von Zeppelin, zoologist at Stuttgart.

A LIFE of Pasteur, written by Prof. and Mrs. Percy Frankland, will very shortly be published by Messrs. Cassell and Co. The volume will form the latest addition to the Century Science Series.

PRINCE ROLAND BONAPARTE has been elected a Correspondant of the Lisbon Academy of Sciences and of the Bologna Academy of Sciences.

THE new number of the invaluable *Minerva Jahrbuch der gelehrten Welt* has for the frontispiece a fine reproduction of a portrait of Dr. Nansen.

THE Paris correspondent of the *Times* states that the statue of Jules Simon, to be executed by M. Fremiet, will probably be erected in the Place de la Madeleine, near which he lived, and will supersede the fountain now standing there.

WE learn from *Science* that a resolution has been introduced in the House of Representatives appropriating 20,000 dollars for the representation of the United States at the International Fisheries Exposition to be held at Bergen, Norway, from May to September of next year.

THE British Institute of Public Health will be styled in future the Royal Institute of Public Health, and Her Majesty the Queen has accepted the office of patron. The Council of the Institute has conferred the Harben Gold Medal for 1898 upon Lord Playfair, and has appointed Prof. W. R. Smith the Harben Lecturer for the year 1899.

INVITATIONS are being sent out for the forthcoming International Congress of Zoölogy. A Committee of Reception has been formed in Cambridge, where the Congress will meet on August 23, 1898. An International Congress of Physiologists will be held at the same time in Cambridge. It is proposed at a later date to distribute further information on the more important subjects which will be brought forward for the consideration of the Congress.

THE personal estate of the late Mr. Alfred Nobel has been valued at 434,093*l.*, of which amount 216,901*l.* is in England. After a number of personal bequests have been made, Mr. Nobel's will stipulates that the capital of the whole of the remaining realisable property is to form a fund, the interest from which is to be annually divided in five prizes to those who during the preceding year have done most for the benefit of humanity. The interest is to be divided into five equal parts, which are to be awarded in prizes as follows: (1) To him who within the department of natural philosophy has made the most important discovery or invention; (2) to him who has made the most important discovery or improvement in chemistry; (3) to him who has made the most important discovery within the department of physiology or medicine; (4) to him who in literature has produced the most excellent work in an idealistic direction; and (5) to him who has worked most or best for the fraternisation of the nations and for the abolition or diminution of standing armies, as also for the promotion and propagation of peace. The prizes in physics and chemistry are to be awarded by the Swedish Academy of Sciences, for physiological or chemical work by the Carolinian Institution in Stockholm, for literature by the Academy in Stockholm, and for the propagation of peace by a committee of five persons to be elected by the Norwegian Parliament. The will continues:—"It is my express will that at the distribution of prizes no regard is to be paid to any kind of nationality, so that the most worthy competitor may receive the prize whether he is a Scandinavian or not."

THE Russian Institute of Experimental Medicine, at St. Petersburg, held its seventh annual meeting on December 20, 1897. The Institute consists of six scientific sections and one practical section, and during the past year no less than 120 persons took part in its regular work, which is carried on in the departments of biological chemistry, physiology, bacteriology, pathological anatomy, general pathology, and epizootic diseases. Sixty-five papers—some of them of high scientific value—were published by the scientific staff of the Institute. In addition to this, no less than 25,000 bottles of diphtheria serum, 800 bottles of anti-streptococcus serum, and 300 bottles of anti-staphylococcus serum were sent out from the Institute during 1897—making a total of 138,000 bottles of anti-diphtheria serum, and 15,000 bottles of malleine and tuberculine that were distributed within the last three years. Of persons bitten by rabid animals, 277 were under treatment, the percentage of deaths having been only 0·7. The serum treatment of the bubonic plague, the prophylactic measures against it, and the preparation of anti-plague serum were the subject of special work during the year, and its results were summed up in a paper which was read at the annual meeting by Prof. A. A. Vladimiroff.

THE following are the arrangements for lectures during January at the Imperial Institute. These lectures will be open free to the public, without tickets, seats being reserved for Fellows of the Imperial Institute and persons introduced by them. Monday, January 10, "Western Australia: its growth and possibilities," by Mr. H. C. Richards, M.P.; Monday, January 17, "South Africa, from the Cape to Ngamiland," by Mr. H. A. Bryden; Monday, January 24, "New Brunswick—Past and Present," by Mr. C. A. Duff-Miller; Monday, January 31, "Through the Gold Fields of Alaska to Bering Straits," by Mr. Harry de Windt.

AT the recent annual meeting of the Paris Academy of Medicine (says the *Lancet*) a report was presented upon the prizes awarded in 1897. The François Joseph Audiffred prize, which consists of 24,000 francs to be awarded to him who shall have, in the opinion of the Academy, discovered a really curative or preventive remedy against tuberculosis, has not been awarded. The offer holds good for twenty-five years, starting from April 2, 1896. Another prize not awarded was the Chevillon prize of 1500 francs offered to the writer of the best work upon cancerous affections—but a consolation prize of 500 francs was given to Dr. Livet for his work on the subject.

MR. JOHN W. BARBOUR, writing from Bangor, Co. Down, Ireland, informs us that an albino lark—believed to be a sky-lark—was shot in that district on December 27, 1897.

MR. B. WOODD-SMITH calls our attention to the following paragraph, which appeared in the *Whitby Gazette* of December 17:—"A splendid meteoric display was witnessed in the eastern heavens on Sunday night [December 12], shortly before eight o'clock. The meteors, which appeared of various colours, were of great brilliance, and illumined the sky with an effulgence greatly surpassing that of the clear and almost full moon shining at the time. About the time of the display, a sound like that of thunder was heard." Further information with reference to these observations would be of interest.

DR. R. F. SCHARFF records, in the *Irish Naturalist*, the discovery of some remains of the wild horse (*Equus caballus*) in Ireland. The remains consist of the occipital part of a skull

and the posterior part of another. Both of these were forwarded to Dr. Scharff, who decided that they evidently belonged to horses, but to specimens of very small dimensions—certainly not larger than an ass. The skulls were discovered, when making a drain in Major Moore's property near Naas (Co. Kildare), resting on the gravel beneath the bog. The remains therefore probably belong to wild horses, which are known to have inhabited Ireland as contemporaries of the Irish Elk. Dr. Scharff points out that all the remains of the wild horse hitherto discovered in Ireland, viz. in Shandon Cave and many Pleistocene deposits, point to the fact that it was of small stature.

AN interesting glimpse of Huxley's home-life is given in the *Century Magazine*, by his son Mr. Leonard Huxley, and it reveals another aspect of his gentle and loving character. After his retirement in 1885, the extra leisure permitted his affection for children to have full play. Of one of his grandsons, Julian, he was very fond, and the following incident shows how he would give rein to his humour and wisdom to please a child. Julian had been reading the "Water Babies," wherein fun is poked at his grandfather's name among the authorities upon water babies and water beasts of every description. The book is illustrated by a picture showing Huxley and Owen examining a bottled water baby under big magnifying glasses, so Julian thought he would consult his grandfather upon the matter. He therefore wrote: "Dear Grandpater—Have you seen a water baby? Did you put it in a bottle? Did it wonder if it could get out? Can I see it some day?" Julian's interrogations are worthy of a Huxley, and this is the reply they received: "My dear Julian, I never could make sure about that water baby. I have seen babies in water and babies in bottles; but the baby in the water was not in a bottle, and the baby in the bottle was not in water." Other stories are told to illustrate Huxley's sympathies with, and tenderness to, the little ones. As is well known, cats were great favourites with him. Like Mahommed who, rather than disturb his cat, cut off the sleeve of his robe on which it had gone to sleep, Huxley would not turn a cat out of his study chair, but would himself sit in a less comfortable seat and leave the cat in peace. At Eastbourne he gave most of his time to gardening, and all through the last years of his life the garden and the flowers were his greatest source of pleasure.

WE learn from the Annual Report of the Director of the Royal Alfred Observatory at Mauritius, for the year 1896, that a new series of publications has been commenced; a separate volume, entitled "Mauritius Magnetical and Meteorological Observations," will contain the daily, monthly and annual values of the principal elements, and will be substituted for the various tables which have hitherto appeared in the Mauritius Blue Book. The rainfall was 18·58 inches above the average for the last twenty-two years. After heavy floods in February (25·94 inches in four days), followed by excessive rain during a severe thunder-storm on May 7, severe droughts were experienced between September and December. An examination of the diurnal variation of rainfall for 1888–96 shows a double oscillation, the maxima occurring at 4h. a.m. and 3h. p.m., and the minima at 10h. a.m. and 8h. p.m., these hours corresponding nearly to the epochs of minimum and maximum barometric pressure. The mean temperature was nearly normal, being only 0°·3 below the average. As usual the logs of ships arriving at the island were copied, so far as the observations related to the Indian Ocean. Photographs of the sun were also taken daily, when the weather permitted, and these have been forwarded to the Solar Physics Committee.

A USEFUL series of records of the Hereford earthquake of December 17, 1896, as it affected the county of Hertford, is contained in a paper by Mr. H. G. Fordham (*Hertfordshire Nat. Hist. Soc. Trans.*, vol. ix., 1897, pp. 183–208). In his summary of the observations, Mr. Fordham notes that the earthquake was felt more or less distinctly over the whole county, though it was naturally more marked on the west side than on the east. There is no clear difference in its recorded effects at places situated at different altitudes and on different rock-formations. While there is a general agreement as to the swaying or rolling character of the movement, there is a conflict of evidence as to accompanying sound. In a large number of cases, a rumbling sound is recorded; but, on the other hand, some very competent observers speak positively as to the absence of noise. There is the usual diversity in the personal impressions with regard to the direction of the movement, with a balance of numbers, however, in favour of a movement along a west and east line.

THE lately issued sixteenth volume of the *Bulletin* of the United States Fish Commission contains an excellent report on the Russian Fur Seal Islands, prepared by Mr. Leonhard Stejneger, of the U.S. National Museum, which should be studied by every one interested in the question. Mr. Stejneger, who has visited the Commander Islands twice—first in 1882–83 in the palmy days of the fur seal industry, and again in 1895 during its decline and fall, and who is a well-known expert on the subject, comes to the conclusion that the only measures likely to stop the ultimate destruction of the fur seals of these islands is the "total and absolute prohibition" of pelagic sealing in the North Pacific for at least six years, and, after that period, the total prohibition of pelagic sealing within a zone of 150 miles from the islands. These measures would, no doubt, be effectual if they could be carried out, and would be much for the benefit of the Russian Seal-skin Company, which holds the lease of the islands; but Mr. Stejneger does not explain how it is proposed to stop seal-catching in the free and open ocean, nor whether the Russian Company, to which the benefit would accrue, is prepared to pay for it.

MR. J. COSMO MELVILL has reprinted from the *Journal of Conchology* his presidential address upon the principles of nomenclature and their application to the genera of recent Mollusca. It contains an historical sketch of the subject as regards pre-Linnæan authors which will be useful, if, as we understand, nomenclature is to be one of the subjects for discussion at the meeting of the International Zoological Congress at Cambridge in August next. Mr. Melvill gives also a useful list of genera of marine Gastropods about the names of which some differences of opinion have existed, and indicates those which he thinks ought to be adopted.

IT is well known to psychologists that some persons experience a sensation of colour in association with certain sounds, the colour seen being definite and invariable for the same sound. Dr. W. S. Colman describes a number of these cases of colour-hearing in the *Lancet* (January 1). Cases of this kind usually fall into two groups. In the first there is a crude colour sensation, often very beautiful, associated with certain sounds such as each of the vowel sounds, musical notes, or particular musical instruments. The appearance is usually that of a transparent coloured film similar to a rainbow in front of the observer, but not obscuring objects. In the second group there are colour sensations whenever letters or written words (symbols of sound) were spoken or thought of, so that when a word is uttered the subject visualises the letters, each having a distinctive tint. A study of the subject leads Dr. Colman to regard the phenomena as "associated sensations" analogous to the cutaneous sensation of shivering in certain parts of the body, varying in different individuals, which is experienced at the sight or thought of an accident, or at the sound of the squeak of a slate-pencil. The tints excited are very definite and characteristic, each for its own

sound. They do not vary as time goes on. The colours are scarcely ever the same in two individuals. This is very clearly shown in two coloured diagrams which accompany Dr. Colman's paper. The first diagram shows the tint excited by the spoken vowel sounds in twenty-one individuals, while the second shews the tints of the colour sensations excited by the letters of the alphabet in seven individuals. Dr. Colman does not, however, give the colour sensations excited by numbers. The writer has tested a boy at intervals within the past four years, and has found that each numeral is associated with a colour as follows:—1, black; 2, white; 3, yellow; 4, red; 5, green; 6, grey; 7, mauve; 8, light grey; 9, brown; 0, black. These associated colours have remained the same throughout the period.

A NEW monthly journal of mechanics and electricity for amateurs and students has just made its appearance under the title of *The Model Engineer*. The periodical is intended particularly for amateurs who take up mechanical or electrical work as a hobby.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Mrs. R. H. Padbury; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mrs. Soames; a Spectacled Bear (*Ursus ornatus*, ♂) from Colombia, a Spotted Cavy (*Cœlogenys paca*) from South America, presented by Mr. William Crosley; three Brown Capuchins (*Cebus fatuellus*), a Blue and Yellow Macaw (*Ara ararauna*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, deposited; a Naked-throated Bell-Bird (*Chasmorhynchus nudicollis*) from Brazil, two Noisy Pittas (*Pitta strepitans*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

WINNECKE'S COMET.—As announced in this column a fortnight ago, Winnecke's periodic comet is shortly due at perihelion, and therefore might be expected to be picked up at any time. Such has been the case, for Prof. Perrine telegraphs from the Lick Observatory that it was found on January 1, being only feebly visible. Its position then was R.A. 15h. 19m. 42·5s., Decl. $-3° 58' 34''$ S.

ARRIVAL OF ECLIPSE PARTIES AT BOMBAY.—Reuter's correspondent at Bombay states that Mr. E. W. Maunder, Mr. C. Thwaites, and the Rev. J. M. Bacon, with the parties under their direction sent by the British Astronomical Association for the observation of the total solar eclipse on the 22nd inst., have arrived there. The different observing stations will be as follows:—Mr. Maunder and Mr. Thwaites will be stationed at Talni, on the Great Indian Peninsula Railway, between Amraoti and Nagpur; the Rev. J. M. Bacon at Baxar. The Astronomer Royal and Prof. H. H. Turner, forming one of the official parties sent out by the joint committee of the Royal Society and the Royal Astronomical Society, will be stationed at Sahdol, between Katni and Bilaspur. The observing party from the Government Observatory at Madras, under the direction of Prof. Michie Smith, will be at Indapur.

MONT BLANC OBSERVATORY.—The closing of the year brings to hand the reports from many observatories, and not the least interesting is that by M. J. Janssen, in *Comptes rendus* No. 24, "On the work done in 1897 at the Mont Blanc Observatory."

During 1897 the principal work has been the determination of the quantity of heat received by the earth from the sun, or the *solar-constant*, as it is called.

The meteorological conditions have not been very favourable, and M. Janssen was compelled to direct observations and expeditions from Chamonix, only reaching there with difficulty, having seriously injured his left leg, which made an ascent of Mont Blanc quite impossible for him. The observations were, therefore, made by M. Hansky—first at Brévent, again at the Grands Mulets, and finally at the summit of Mont Blanc, at the observatory.

From these observations a *solar-constant* of nearly 3·4 calories has been deduced; that is to say, a value notably higher than that obtained before. This, M. Janssen thinks, will be still further increased, for the more deeply the question is studied the more one ascertains the complexity of the elements which enter into it. For instance, of the radiations which strike the earth, it is those having wave-lengths of large and small periods that undergo the greatest absorption in the atmosphere; those with a mean wave-length corresponding to the most luminous part of the spectrum are propagated with the least relative loss. As a result of this, if the transmission of heat in a zenithal direction be deduced from observations made through a great thickness of the atmosphere, it will give a value much too high, and hence one much too small for the solar radiations outside the limits of our atmosphere, which value is the solar-constant. Again, the presence of water vapour and dust particles, whether of snow or other matter, all give rise to disturbing effects which influence the results. To obtain precise indications of water vapour the spectroscope has been used, and for the dust particles and snow clouds M. Cornu's form of polariscope has been employed with success.

From these results it can be seen that it is desirable the observations should be made with as little atmosphere intervening as possible; that is, at high altitudes—in balloons even, if sufficiently precise instruments could be used in these regions of the atmosphere. Nevertheless, if stations such as that of Mont Blanc do not offer comparable altitudes with those which balloons can reach, in return they permit the use of instruments more delicate and precise, giving trustworthy results.

PHOTOGRAPHY OF UNSEEN MOVING CELESTIAL BODIES.—Quite recently Prof. Barnard showed in *Astr. Nach.*, 3453, how it might be possible to photograph an "unseen moving but known celestial body," as, for example, unseen comets, or the swarm of meteorites giving rise to the November shower. The method, it may be remembered, was to watch with a guiding telescope and keep an adjacent star on cross wires moving in the correct position angle at the proper rate, the movement to be produced by an arrangement of watch-work. In *Astr. Nach.*, 3467, Herr Josef Jan Fric, of Prague, gives an account of a somewhat similar method in which the photographic plate or object glass is moved in the requisite direction. The holder is driven by a fine screw, which derives its motion from the intermittent action of a ratchet wheel moved by a "powel," which in turn is actuated at will by an electro-magnet. The length of stroke can easily be altered so as to give any varying motion which may be necessary, but of course, in consequence of the discontinuity of the movement produced in this way, the change in the position of the plate must be so small as not to interfere with the perfectness of the image photographed.

ASTRONOMICAL ANNUALS.—Perhaps the most useful annuals for use, either in a well-established observatory or by amateurs, are: the *Companion to the Observatory* and the *Annuaire Astronomique et Meteorologique;* and if these two could be compounded together, they would form a most desirable and complete compendium of astronomical data. The former confines itself chiefly to tabular matter giving data for finding the planets and their satellites with their respective phenomena, occultations, and eclipses. In addition to these, and perhaps the most important section, as it is not readily found elsewhere, is the ephemeris for physical observations of the sun, mean places, and maxima and minima of variable stars of all periods, and also the radiant points of the principal meteor showers of the year.

The latter publication, by M. Camille Flammarion, is in its thirty-fourth year, and while treating of astronomical events in a popular way, it gives numerous diagrams, and has many interesting features. The calendar, detailing observations to be made for each day, has proved itself most useful, as also have the charts of the positions of the planets.

PHOTOGRAPHIC MEASUREMENT OF HORSES AND OTHER ANIMALS.

VALUABLE horses are habitually photographed by professionals and amateurs, and beautiful portraits of them appear in newspapers; notably in *Racing*, in the *Horseman* of the U.S.A., in *Le Sport Illustré*, and in other similar periodicals. I am informed that in shows of pedigree stock it is frequently required that the prize-winners should be photographed, it being of obvious importance that the appearance of the progenitors of animals should be known before selections are made for pairing. It seems, then, that if photo-

graphs of horses and other pedigree stock could be rendered available for strict scientific studies in heredity, the material is copious, and as it would in time extend through many generations, should far exceed in value anything that is now procurable for those purposes. But all depends on that "if." The basis of science is exact measurement, for which the existing photographs are unsuitable. My present object is to show that by paying strict regard to conditions of a simple kind, an ordinary photograph will be transformed from a mere picture into a record of real scientific value; so that if photographs should hereafter be habitually made of pedigree stock (not only of horses) under those conditions, and be afterwards published, a mass of material would quickly accumulate, sufficient to advance the science of breeding far beyond the point at which it now stands. Artistic photographs

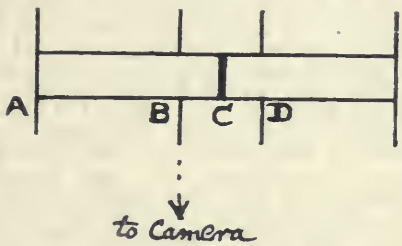

FIG. 1.

are not to be discouraged. Their object is to exhibit animals in their more attractive positions, as by inclining the fore part of their bodies to the camera when it is desired to make the shoulders look larger than they are. What I desire is that other and inexpensive photographs should be procurable, which shall be suitable for exact measurement.

All that is asked for is a strip of hard level ground, on which a rectangle is laid out of some 8 or 9 feet (say 100 inches) long and 20 inches wide, and otherwise marked, and that the camera shall be directed squarely towards a certain point in it, as shown by the diagram (Fig. 1). The horse is to be led to the rectangle, and kept in it, taking care that all his feet stand within its margins, that the cross-line at C lies clear of his front and

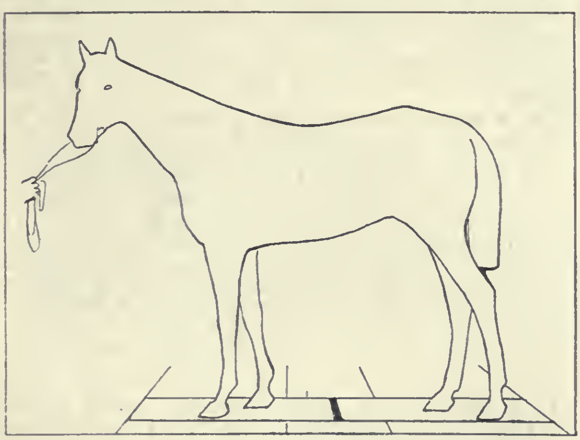

FIG. 2.

hind legs, and that the tip of every hoof and each corner of the rectangle is visible from the camera. The appearance of the horse standing upon the rectangle, as seen in the photograph, would be this (Fig. 2), but the lines should be much more delicate. The camera should be placed on a line strictly at right angles to the side A E of the rectangle. When the horse's head, as in Fig. 2, is on the side of A, the perpendicular in question should be drawn from B, a point about a foot distant from C, and on the same side as A. Then the image of the horse fits, laterally, well into the field of the camera. When the horse's head is intended to be on the side of B, a symmetrically situated point D must be selected for the foot of the perpendicular on which the camera is to stand. The distance of the latter from the rectangle should be fully 20 feet.

The camera having an adjustable back, must be slightly tilted downwards in order to get a good view of the feet, but its back must be kept *strictly vertical*. It would be a decided gain if the installation were so arranged, that the photograph should contain means of judging whether the plate in the camera had really been adjusted aright—that is, parallel to the vertical planes passing through the long sides of the rectangle. This can be accomplished by laying out the rectangle near the base of a wall, with its long sides parallel to it; then, driving two nails into the wall in the same horizontal line, hang a long string with weighted ends over them, the ends nearly touching the ground. If the two nails are well placed, the line will appear in the photograph, as running along the top and down the two sides of it, close to the margin. Then, if the plate has been rightly adjusted, the upper line in the picture will remain parallel to the long sides of the rectangle, and the two weighted ends will remain parallel to one another. Otherwise there will be convergence in one or both respects. The camera must be high, in order to show well the position of the horse's feet; 5 feet is perhaps the best height for it at a distance of 20 feet, then the perspective foreshortening of the width of the rectangle is such that its scale is one-quarter of that of its length.

Relative measurements can be made with accuracy on photographs taken under these conditions, between any visible points that are situated on the median plane, such as between the withers and the lower part of the chest below them, between the front and the back of the profile, and so on, but absolute measurements cannot be made because the distance between the camera and the median plane is not yet accurately determined. Much less can heights above the ground be measured, for in order to do so it is necessary first to determine the line at which the median plane of the horse intersects the ground, because it is to this line that the vertical measurements must be made. What is meant by "median plane," is the imaginary plane which passes lengthways and vertically through the spine of the animal, and which serves generally as a plane of reference. It cuts the ground half-way between the two pairs of hoofs, so that if the half-way position between the tips of the fore hoofs be called S, and that between those of the hind hoofs be T, then the intersection of the median plane with the ground lies along the line S T. For its accurate determination the animal should stand on hard ground, and the hoofs be so disposed that at least the tips of all four shall be visible from the camera, which must be well elevated so as to look down on them, as already described.

Beginning with the simplest case, namely that in which the median plane of the horse is parallel to the long sides of the rectangle, and also parallel to the plate in the camera, we are at once in a position to measure the height of the horse, its depth of body wherever desired, and its length. For by prolonging S T in the photograph until it cuts the ends of the rectangle in S′ and T′, a length equal to that of the line S′T′ drawn on the median plane in any direction will correspond to the length of 100 inches objectively. We begin by measuring the lengths of S′T′, and those of any other, say two, dimensions on the photograph. Call their several measurements s', a, and b, reckoning them according to the scale used throughout for that purpose, whatever the value of the units of that scale may be. Let x and y be the objective values of a and b, which have to be found;

$$\text{then } s' : 100 :: a : x \text{ and } :: b : y$$

$$x = \frac{100}{s'}a \qquad y = \frac{100}{s'}b,$$

so the coefficient $\frac{100}{s'}$ being determined, serves to convert these and all other measurements in this same median plane into their objective values. Those persons who possess Crelle's Multiplication Tables, can perform these little sums without effort and with great rapidity. In Fig. 2 the real length of the rectangle there represented happens to be only 80 inches. The measurements on the diagram are as follow:—(1) S′ = 21·6 mm.; (2) height of withers, 15·7; (3) height of lower side of chest, vertically below, 8·9; (4) height of rump, 16·2; (5) extreme length of body, 15·5. Whence the coefficient $= \frac{80}{21\cdot6} = 3\cdot7$, and the objective values are (2), 58·1 inch, (2-3) 25·1; (4), 59·9.

Before considering the effect of obliquity the following objection must be disposed of. It may be said that the protuberan- sides of the animal will prevent its true outline being visible

from the camera, for the reasons indicated by Fig. 3, which is an extreme case in which the camera, or eye, R is supposed to be very near to the side of an animal, so fat that his cross section has to be represented by a circle.

The summit of the outline as seen from R is H, giving the idea that the spine of the animal is as high as L, whereas it is really at K. The ratio of LO to KO is of course the same as that of LO/OR to KO/OR, that is to HO/OR; in other words as the tangent of L R O to the sine of the same angle. The values to be dealt with in reality, are very different from those in the diagram. OR is 240 inches and KO may be taken as 15 inches. It results that L R O is only 3° 35′. Now the tangent and sine of such a small angle are so nearly alike that LO : KO :: 100·00 : 99·85, which corresponds to a difference of less than 1/8th inch in a horse of 15 hands high, and is quite negligeable.

In some fat stock, however, the backs are flat like tables. Here some artifice would be necessary to obtain the true height, such as by fixing a stud of say 2 inches in height to a surcingle. The top of the stud would then be the point of measurement, and 2 inches would be subtracted from the result.

We now come to the effect of obliquity of the median plane of the horse to the long sides of the rectangle. The hoofs of a thoroughbred horse are some 4 inches wide, and 4 inches apart, so that the closest distance between either S or T, and the nearest side of the rectangle, is 6 inches; therefore the utmost cross distance between S and T is (20 – 12) or 8 inches, and the length of ST in a horse of 15 hands in height may be taken as 60 inches. Therefore the maximum obliquity within the strip is as 8 to 60, or 0·1333, which corresponds to an angle of 7° 39′.

The foreshortening of the length ST (= 60 inches) is such that its foreshortened value must be multiplied by the secant of 7° 39′

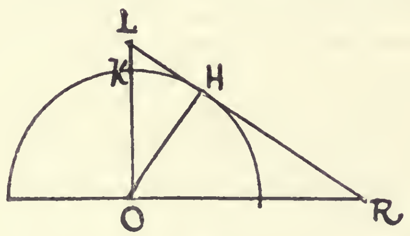

FIG. 3.

to obtain the unforeshortened value, that is by 1·009, which makes it nearly 1 per cent. longer. This is the greatest error to be feared under the conditions, and it is further much diminished by determining the actual obliquity. We can do this easily by measuring the distance lengthways between the points where ST produced cuts the opposite sides (not ends) of the rectangle. The further side of the rectangle affords the scale for reckoning distances from C along that line when produced; similarly the nearer side affords the scale for distances from C measured along and beyond itself. The cross distance between those points is known to be 20 inches, so the obliquity is easily found. The accompanying table may be found convenient. It applies with strictness only to objects viewed from a great distance, but is practically correct for much smaller ones.

Obliquity.		Multiplier to convert fore-shortened values.	Corrections to be added to foreshortened measurements of			
			10 ins.	30 ins.	50 ins.	70 ins.
	° ′		in.	in.	in.	in.
1 in 7	8 12	1·0103	0·100	0·20	0·50	0·70
,, 10	5 43	1·0050	·050	·15	·25	·35
,, 15	3 49	1·0022	·022	·07	·11	·15
,, 20	2 52	1·0012	·012	·04	·06	·09
,, 25	2 18	1·0008	·008	·02	·04	·06
,, 30	1 55	1·0006	·006	·02	·03	·04

The mean scale for the slightly oblique median plane is the perspective length of the rectangle at the point where a line drawn through the middle of ST cuts the perspectively viewed ends of the strip. It is unnecessary to attempt greater minuteness, as by determining the vanishing point (the position of which is given by prolonging two or more of the cross-lines upon the ground to their points of common intersection in the photograph), and then employing the further methods known to draughtsmen in perspective. Much could be written of which it is unnecessary to speak here, because it is a condition that the obliquity shall never be great. A strict attention to the elementary requirements laid down above, makes the problem of measurement extremely simple; otherwise it becomes complex and troublesome.

The next point to be considered is the method of measuring between points situated on the side of the horse, such as from the haunch bone to the shoulder. I shall speak of these in general terms only, because the most suitable points for measurement have yet to be determined. Whatever they be, it is a great assistance, before photographing the horse, to mark the points to be measured either by chalk, or more neatly by a disc of gummed paper, the size of a shilling, wetted and stuck on. Veterinary-Captain F. Smith has used both these plans. It is also an excellent plan to prick through these points in the photograph, and through a piece of paper laid below, and to measure between the prick holes. The general principle of dealing with these measurements is to find a *mean* correction suitable to each distance, when those distances have been calculated as if they were situated on the median plane. The lateral deviation from that plane of each one of these points, ranges within narrow limits, when the height of the horse is taken as unity. The mean deviation even of either protuberant haunch bone from the median plane between them, is much under 20 inches in a horse of 60 inches (15 hands in height). The mean range of this deviation in different horses of that height, judging from what occurs in anthropometric measurements, is probably very much under an inch, and its extreme range in ordinary cases would be under 2 inches. Extraordinary cases of massive or slender build would be betrayed by the photograph itself, and could be allowed for. It seems, then, that after the desirable points had been determined, between which measurements might be wanted, it would be a straightforward piece of work to make numerous measurements between them in different horses, and to draw up the suggested table of corrections for 2 or 3 different positions in the rectangle.

The head and neck can hardly be measured on the above principles, as it is very difficult to ensure that their median plane should be the same as that of the body. A strip of card chequered with inches, alternately white and black, and fastened to the head stall, affords a serviceable scale, and is by no means unsightly.

From measurements obligingly procured for me by Dr. MacFadyean, the Principal of the Royal Veterinary College at Holloway, the measurements being repeatedly made of the same horses by different pupils, I learnt two things. One was that horses of the same class vary among themselves as much as men. In short, they could be identified by a Bertillon method. The other was that the fallibility of a measurer was considerable. I think that measurements made on a half-plate photograph, under the conditions I have described, would on the whole be more trustworthy than direct measurements made with a tape or callipers, especially on fidgety horses.

FRANCIS GALTON.

THE MAGNETIC PROPERTIES AND ELECTRICAL RESISTANCE OF IRON AT HIGH TEMPERATURES.

THE magnetic properties of iron and, to a lesser extent, of the associated metals, nickel and cobalt, have always been a fascinating subject of study. Possessed by these three metals alone, these properties, so peculiar and so different from any of the other known properties of matter, have imparted to the study of these so-called magnetic metals a special charm and interest, apart from that excited by the vast industrial importance of at least one of them.

Among the very early inquiries into the nature of magnetism there were not neglected experiments on the effect produced by change of temperature. Three centuries ago, Gilbert recorded the observation that a piece of iron or steel, if heated more strongly than up to a full red heat, ceased to be attracted by a magnet, though it regained its previous magnetic qualities on cooling below that temperature.

Until comparatively recently, however, accurate magnetic measurements, even at ordinary temperatures, could alone be made on *permanent* magnets and the forces acting on their poles. The capability of acquiring *temporary* or induced magnetism when near a magnet, which is the characteristic property of soft iron, could not be subject to strict measurement until it was shown, firstly, how a given specimen of iron could be uniformly magnetised in a uniform magnetic field; and secondly, how both the magnetising force of that field, and the consequent magnetisation of the iron could be measured. We know of only one way of completely satisfying the first condition: namely, by covering a ring-formed specimen (whose outer diameter but slightly exceeds the inner) with a uniform layer of insulated wire carrying an electric current, thus forming a ring-magnet with no disturbing poles. And Faraday's researches on electro-magnetic induction have furnished us with a method, at once accurate and convenient, of determining the magnetisation of the apparently unmagnetised ring magnet, *i.e.* by the use of a "secondary winding" or outer layer of insulated wire, connected with a "ballistic" galvanometer. Knowing then the intensity of magnetisation called up by a given magnetising force, we can, from their ratio, express the facility with which the iron takes up magnetic induction, or, in other words, its magnetic *permeability*.

To apply this method to the measurement of permeability at high temperatures, both the magnetising and the secondary winding must be so insulated as to be uninjured by the heating; and further, the thermometer or pyrometer, which measures the temperature, must be placed inside the ring, so as to measure the actual temperature of the iron.

Among the earlier important researches on magnetic properties at high temperatures, that of Baur of Zürich, in 1879, should be mentioned. He experimented simply on an iron bar heated in a furnace, and thence rapidly transferred to the interior of a straight magnetising coil. Not, however, till 1889 was it shown by Dr. Hopkinson, in his classical researches, that the ring-magnet method could be successfully applied to the measurement of permeability at high temperatures. The windings of the ring-magnets were in this case of copper wire insulated with asbestos; the heating was carried out in a gas furnace; and the rise of temperature of the iron core was deduced from the increase of the electrical resistance of the secondary winding.

Of the more recent researches, the most remarkable is that of M. Curie, published in 1895, describing experiments on the magnetic behaviour of a great variety of substances, at temperatures ranging up to a white heat. The method he adopted—that of finding how strongly the specimens were attracted, when placed near a powerful magnet, was well adapted to determine permeability in intense magnetic fields, but it is much inferior to the ring-magnet method, where the permeability varies much with the magnetising force, as is the case whenever the magnetic field is not intense.

In the course of some experiments on the subject of this article, the results of which have been recently published, I have endeavoured to approximate, where possible, more closely than previous experimenters to the ideal method which would be the outcome of the principles laid down above. The ring-magnet, whose core was the iron specimen to be tested at high temperatures, was made very small, measuring about one inch across. The temperature of this core was determined by means of an electrical thermometer *embedded in it*, consisting of a wire of pure platinum whose electrical resistance at any temperature had been previously determined, and whose resistance, therefore, if subsequently measured, gave its temperature, and hence also that of the iron core in which it was laid. Asbestos paper insulation, as had been used by former experimenters, was found to be very imperfect at high temperatures, owing largely to carbon deposited from the materials used in its manufacture. This difficulty was, after some trouble, overcome; but wherever a high degree of insulation was wanted, as in the case of the thermometer wire and secondary winding, it was found necessary to employ *mica*, though, as may well be imagined, the use of such an untractable material for such a purpose is beset with considerable mechanical difficulties.

Now, to find the magnetic condition of a sample of iron at a given temperature with any completeness, it is not sufficient merely to measure its permeability in various magnetic fields; the behaviour of the iron when subjected to what is called a "cyclic" process of magnetisation must be studied—the "hysteresis," or energy, absorbed in one double reversal of the magnetisation of each cubic centimetre of the iron, must be measured.

But the taking of so many observations requires time; and if, during this time, the temperature of the iron be not perfectly constant, all efforts at refinement in the magnetic measurements are thrown away. The heating of the ring must, then, be thoroughly under control. The method I adopted was an electrical one. The ring-magnet was furnished with an extra winding of asbestos-insulated platinum wire, so wound as to have no magnetising influence; and by passing through this wire a suitable electric current, heat could be generated in the ring at any desired rate. This method, however (the principle of which was adopted as long ago as 1888 by M. Ledeboer) is not used to full advantage unless combined with an effort to thermally isolate the body to be heated. Each ring-magnet was therefore thickly wrapped with asbestos, and supported in the centre of a closed and partially exhausted glass vessel (oxidation of the iron core was also in this way avoided).

This method of heating proved most satisfactory. The loss of heat by radiation and conduction being slight, the ring-magnet could not rapidly alter its temperature; and there is probably no way in which we can supply heat-energy to a body, which can compete with the electrical resistance method, either as regards constancy or control. For obtaining temperatures up to 1300° or 1400° C.—a white heat—this method, combined as far as possible with "thermal isolation," and an electrical method of measuring the temperature, should in the future prove of the greatest value in all cases where the physical properties of bodies at high temperatures require careful investigation.

The original intention of my experiments was to ascertain exactly in what way the specific electrical resistance of iron changes at and about the "critical temperature" at which the magnetic properties of iron so nearly disappear, so as to throw light if possible on the molecular state which we characterise by the term "magnetic." With this object the iron core of the ring-magnet was formed of a long insulated iron strip, among the turns of which the platinum thermometer wire was buried; and with this piece of apparatus simultaneous measurements of the magnetic qualities and electrical resistance of a sample of iron could be made with accuracy alike at low and high temperatures.

Let us now consider the magnetic changes which occur in soft iron when heated. At ordinary temperatures iron shows a kind of unwillingness, so to speak, to become *slightly* magnetised—its permeability under small forces is not great. Beyond a certain limit, however, it exhibits the greatest readiness to become further magnetised, and continues to have a high permeability until magnetised very strongly. But from this point it begins to show signs of magnetic *saturation*, and ultimately refuses to be further magnetised without the application of very great force.

Now, as the temperature of the iron is gradually raised, it is found that practical magnetic saturation takes place sooner and sooner. Iron refuses to become so strongly magnetised at higher temperatures. Thus the permeability in strong magnetic fields falls off as the temperature rises—very slowly at first, then more rapidly, till, near the "critical temperature," the permeability rapidly drops to quite a low value.

On the other hand, in weak magnetic fields, the behaviour of iron up to within a few degrees of the "critical temperature" is precisely opposite. The permeability *rises* with the temperature—at first slowly, then above 500° C. with ever increasing rapidity, until at last that lack of susceptibility to small forces disappears, and iron shows itself just as amenable to magnetic influence in small magnetic fields, as in the larger ones, where the maximum permeability occurs.

At this temperature—say 15° below the critical temperature (about 750° C.—a red heat), iron possesses all those qualities at once which are sought after by the transformer maker:—Practical absence both of hysteresis and of eddy currents (the latter owing to the greatly increased electrical resistance), and a permeability nearly four times as great as that attainable in commercial transformer iron. So magnetic, indeed, is the iron, that even the earth's magnetic field, in the direction of its greatest intensity, is enough to induce strong magnetisation ($B = 5000$), in fact almost saturate the iron (for which at this temperature a relatively low induction suffices). The behaviour of a compass needle near a slowly cooling ingot of cast steel, should be rather interesting,

for just below the critical temperature the vertical ingot must behave as a very powerful magnet indeed.

For all the lesser magnetic fields, there is a temperature of maximum permeability which is nearer to the critical temperature the smaller the magnetic field. But *at* that temperature the magnetic qualities in almost all fields practically vanish. Hence, when the magnetising force is very small, the change from enormously magnetic to almost non-magnetic takes place with extreme suddenness.

Above the critical temperature, iron is but feebly magnetic; yet it is still much more readily affected by a magnet than most other feebly magnetic bodies. Not till a white heat is reached, do the magnetic qualities of iron become imperceptible.

It is not easy in an article like the present to deal with the changes which occur in the electrical resistance of iron, but the following remarks may be of interest:—

The experiments of Dewar and Fleming have shown that at a temperature of $-200°$ C. the specific electrical resistance of iron is extremely low. Throughout the range of temperature included between that extreme of cold and the critical temperature, about $+780°$ C., the resistance rises at a steadily increasing *rate*, so that at the latter temperature it is over 150 *times* as great as at the former: far in excess of that of any known alloy at ordinary temperatures (crystalline metals and their alloys excepted), and about equalling liquid mercury for high specific resistance. On still further raising the temperature of the iron, it is found that the *rate* of rise of resistance, instead of further increasing, very rapidly falls off till, at a white heat, the resistance of iron increases only slowly with the temperature.

It has long been known that this *increasing rate of rise* of resistance with temperature is a characteristic possessed by the magnetic metals alone. Here now we see that no sooner does the iron cease to be strongly magnetic than this quality disappears, and becomes exchanged for an opposite one, namely, a *decreasing* rate of rise of resistance with temperature. In some hitherto unpublished experiments on Hadfield's manganese steel (a non-magnetic steel which can be rendered magnetic by annealing), I have observed a precisely similar change of the resistance-temperature function to take place during the annealing of this steel, thus furnishing a second case of this obscure resistance-change accompanying the change from magnetic to non-magnetic, in one and the same sample.

The connection between magnetic and electrical properties is evidently not a very simple one, but in the face of these facts it is hard to deny that there is one; and it is only by trying to find out how the various physical properties depend upon magnetism that we may hope to arrive at a comprehensive explanation of that obscure but most interesting condition of matter.

DAVID K. MORRIS.

EARLY MAN IN SCOTLAND.[1]

IN Scotland, as in other countries, man existed before the time of written history. The conditions under which his remains are found, and the works which he has left behind him, provide the data for determining their age, not absolutely or capable of being expressed in numbers of years, but relatively to each other.

Marked differences existed in the physical conditions of Scotland, and indeed in the northern parts of England also, as compared with the southern districts of England and the adjoining parts of France and Belgium at the first appearance of primeval man in those countries. It is the more necessary, therefore, that the conditions then prevailing in Scotland should not be overlooked.

No evidence sufficient to satisfy geologists has been advanced to prove that man existed in Britain during the period called Tertiary. So far, indeed, as Scotland is concerned, even if it were admitted that in other parts of the globe man had been on the earth during Tertiary times, there is little likelihood that his remains could have been preserved; for in that country the Tertiary is represented chiefly by volcanic rocks, and a few patches of sand and gravel with rolled sea shells belonging to the closing stages of that period.

From the careful study which geologists have given to the surface of Scotland, it is evident that at the commencement of the period termed Quaternary or Pleistocene, immediately succeeding the Tertiary, the whole of the country was covered with ice which formed a great sheet 3000 or 4000 feet thick in the low grounds, of which the lower boulder clay, or Till, as it is termed, was the ground-moraine.

As an upper boulder clay also occurs, which is often separated from the lower boulder clay by stratified deposits, some of which contained marine, and others fresh water and terrestrial organic remains, it is obvious that the Ice Age was not one uninterrupted period of continuous cold.[1] The lower and upper tills are the ground-moraines of independent ice sheets, each indicating a distinct epoch, separated by an interglacial period. The earlier epoch was that of maximum glaciation, and the ice sheet extended over the north and middle of England, as far south as the Thames Valley and the foot of the Cotswold Hills; but the high moors in Derbyshire and Yorkshire and the tops of the highest mountains in Wales and Scotland rose above its surface. The great Mer de Glace stretched westward over Ireland into the Atlantic, whilst on the east it was continuous across the North Sea with a similar ice sheet which covered Scandinavia and the region of the Baltic, and extended south to the foot of the hills of central Europe, and overspread much of the great central plain. In the extreme south of England, therefore, the conditions differed from those that obtained in the country further north. Although not actually covered with a sheet of ice, yet the more southern counties had been of necessity under the influence of cold, and must have been subjected to the effects produced by rain and snow, by freezing and thawing.

During the succeeding interglacial epoch the climate eventually became temperate and genial, and vegetable and animal life abounded. It is to this stage that most of the Pleistocene river alluvia and cave deposits of England and the adjacent parts of the continent are assigned. The British Islands appear at that time to have been joined to the continent, and the same mammalian fauna then occupied Britain, France and Belgium, which implied similar climatic conditions. As examples of these, it may be sufficient to name the larger mammals, as the cave and grizzly bear, the hyæna, lion, Irish deer, reindeer, hippopotamus, woolly rhinoceros, straight-tusked elephant and mammoth, all of which are now either locally or wholly extinct.

Abundant evidence exists that man was contemporaneous with these mammals in western Europe, as is shown by the presence of his bones alongside of theirs, and of numerous works of his hands, more especially the implements and tools which he had manufactured and employed. To a large extent these consisted of flint, rudely chipped and fashioned. To these implements, and to the men who made them, the well-known term "Palæolithic" is applied. But along with these, other implements have been discovered, made from the bones, horns and teeth of the larger mammals, on some of which animal forms and incidents of the chase have been sculptured both with taste and skill. Up to now, however, no trace of pottery which can without question be referred to Palæolithic men has been found, and no habitations, except the caves and rock shelters which nature provided for them.

One may now consider how far northwards in Britain Palæolithic man and the large mammals, with which he was contemporaneous, have been traced. The exploration of caverns, made by Prof. Boyd Dawkins and other geologists associated with him, has proved that bones of certain of the mammals of this epoch were present in caves in Derbyshire, Yorkshire and North Wales, and that human remains and implements of Palæolithic type have been found along with them in the Robin Hood cave in the Cresswell Crags, and in caverns in North and South Wales.

When Scotland is considered, evidence of the existence of the mammals of this epoch is not so abundant, yet the interglacial beds of that country have yielded remains of mammoth, reindeer, Irish elk, urus, and horse. But notwithstanding the keen scrutiny to which the superficial deposits in Scotland have been subjected by the members of the Geological Survey and others, no traces either of the bones of Palæolithic man or of the work of his hands have been discovered in North Britain. This, indeed, is not much a matter of surprise, for it must be remembered that, subsequent to the genial interglacial epoch, another ice sheet, that of the upper boulder clay, made its appearance, grinding over the surface of the land, wearing away alluvia, and largely obliterating the relics of interglacial times. Hence inter-

[1] A discourse delivered at the Royal Institution, London, by Sir William Turner, F.R.S.

[1] For the evidence on which these statements are based, consult the "Great Ice Age," by Prof. James Geikie, edition 1894, also his "Classification of European Glacial Deposits," in *Journal of Geology*, vol. iii., April-May 1895.

glacial beds occur only at intervals and are very fragmentary. Nor in Scotland are there any caves similar in dimensions to those which in England and elsewhere have yielded such abundant traces of Palæolithic man and his mammalian congeners. If Palæolithic man ever did exist in Scotland, and there is no reason why he might not have migrated northward from Yorkshire and Wales, yet one could hardly expect to discover traces of his former presence. In Scotland there are no massive limestones, with extensive caverns, in which man could have sheltered, and in which his relics and remains could have been secure from destruction during the advance of the second ice sheet. It is only in the alluvial deposits of interglacial times that such traces have been preserved, but these deposits, as we have seen, were ploughed out and to a great extent demolished by the later sheet of ice. The shreds that remain, however, are of extreme interest, from the fact that they contain relics of the Pleistocene mammals, with which Palæolithic man was contemporaneous; and there is a bare chance that some day traces of man himself may be encountered in the same deposits.

Geologists have shown that in the regions which were overflowed by the second or minor ice sheet no traces of Palæolithic man, or of the southern mammals with which he was associated, have ever been met with in British superficial alluvia. When found in those regions out of Scotland, they occurred in caves chiefly, and sometimes in the stratified deposits which here and there underlie the upper boulder clay and its accompanying gravels.

So far as Scotland is concerned, one must look for a period subsequent to the melting of the second great ice sheet for evidence of the existence of early man. After its disappearance important fluctuations in temperature and in the relative level of land and sea took place from time to time, so that the climate and the area of land in Scotland differed in some measure from what is known at the present day. Eventually a period of cold again occurred, not so severe, undoubtedly, as in the two preceding glacial epochs, but sufficient to bring into existence considerable district ice sheets and extensive valley-glaciers in the Highlands and Southern Uplands. Scotland at this stage was partially submerged, and many of the Highland glaciers reached the sea and gave origin to icebergs. The submergence slightly exceeded 100 feet, and the marine deposits formed at the time are charged with arctic shells and many erratic blocks and débris of rocks. On a subsequent elevation of the land, the beach formed at this level constituted a terrace, well marked on the coast line in many districts, and now known as the 100-foot beach.

There is good reason to believe that the elevation referred to was of sufficient extent to join Britain again to the continent. It is to this stage that the great timber trees which underlie the old peat bogs of Scotland are referred. The peat with its underlying forest bed passes out to sea, and is overlaid in the Carse lands of the Tay and the Forth by marine deposits, which form another well-marked terrace, the 45 to 50 foot raised beach of geologists.

Thus the elevation of the land that followed after the formation of the 100-foot beach coincided with an amelioration of climate and with the presence of an abundant vegetation, and large mammals, such as the red-deer, the elk, and the *Bos primigenus* roamed through the woods. While these conditions obtained partial submergence again ensued, and the sea rose to fifty feet, or thereabouts, above its present level. Within recent years it has been shown that during this period of partial submergence glaciers reached the sea in certain Highland firths, which would seem to show that the climate was hardly so genial as during the preceding continental condition of the British area, when that region was clothed with great forests. Ere long, however, elevation once more supervened, and the sea retreated to a lower level. Here it paused for some time, and so another well-marked terrace was formed, which is known as the 25 to 30 foot beach.

There is not any evidence of the presence of man in Scotland during the formation of the 100-foot beach or terrace, but one can speak with certainty of his presence there during the period of formation of the later beaches. If one could put oneself into the position of an observer who, at the time of the 40-50 foot submergence, had stood on the rock on which Stirling Castle is now built, instead of the present carse lands growing abundant grass and grain, and studded with towns, villages, and farmhouses, one would have seen a great arm of the sea extending almost if not quite across the country from east to west, and separating the land south of the Forth from that to the north. In this sea great whales and other marine animals disported themselves, and sought for their food. Abundant evidence, that this was the condition at that time in the Carse of Stirling, is furnished by the discovery during the present century of no fewer than twelve skeletons of whalebone whales belonging to the genus Balænoptera or Finner whales, imbedded in the deposit of mud, blue silt and clay which formed the bed of the estuary.[1] This Carse clay, as it is called, is now in places from 45 to 50 feet above the present high-water mark, and is extensively used for the manufacture of bricks and tiles. At a still lower level lies the carse clay of the 25-30 foot terrace. Until the beginning of the present century the clay had been covered by an extensive peat moss, which the proprietors of the land have removed. The question which has now to be considered is—Did man exist in Scotland at the period of the formation of the carse clays and of the two lower sea beaches? There is undoubted evidence that he did.

Along the margin of the 45-50 foot terrace in the neighbourhood of Falkirk one comes upon the shell-mounds and kitchen-middens of Neolithic man. All these occur on or at the base of the bluffs which overlook the carse lands—or, in other words, upon the old sea-coast. Again, in the Carse of Gowrie, a dug-out canoe was seen at the very base of the deposits, and immediately above the buried forest-bed of the Tay Valley. The 25-30 foot beach has been excavated out of the 40-50 foot terrace; it is largely a plain of erosion rather than of accumulation. It is probable, therefore, that many of the relics of man and his contemporaries which have been obtained at certain depths in the 25-30 foot beach may really belong to the period of the 40-50 foot beach. Some of these finds will now be referred to.

In 1819 the bones of a great Fin-whale, estimated about 72 feet long, were exposed in the carse land adjoining the gate leading into the grounds of Airthrey Castle, near Bridge of Allan, about 25 feet above the level of high water of spring tides. Two pieces of stag's horn, through one of which a hole about an inch in diameter had been bored, were found close to the skeleton. In 1824, on the estate of Blair Drummond, in the district of Menteith, a whale's skeleton was exposed, and along with it a fragment of a stag's horn which was said to have a hole in it and to have been like that found along with the Airthrey whale. Mr. Home Drummond also states that a small piece of wood was present in the hole, which fitted it, but on drying, shrunk considerably. Unfortunately these specimens have been lost, and no drawings or more detailed descriptions were ever apparently published, though in some geological and archæological works they have been stated, without any authority, to have been lances or harpoons. Twenty years ago the skeleton of another whale was exposed at Meiklewood, Gargunnock, a few miles to the west of Stirling, and resting upon the front of its skull was a portion of the beam of the antler of a red deer, fashioned into an implement eleven inches long, and six and a half inches in greatest girth; a hole had been bored through the beam, in which was a piece of wood one inch and three-quarters long, apparently the remains of a handle. The implement was truncated at one end, and shaped so that it could have been used as a hammer, whilst the opposite end was smooth and bevelled to a chisel or axe-shaped edge formed by the hard external part of the antler.[2] There can be no doubt that this implement resembled those found alongside of the Airthrey and Blair Drummond whales earlier in the century, and it effectually disposes of the statement that they were lances or harpoons. Dug-out canoes have indeed been found imbedded in the Carse clays at a similar level, so that the people of that day had discovered a means of chasing the whale in the water; one can, however, scarcely conceive it possible to manufacture a horn implement sufficent to penetrate the tough skin and blubber of one of these huge animals, and to hold it in its efforts to escape. It is much more probable that the whale had been stranded at the ebb of the tide in the shallower water near the shore, and that the people had descended from the neighbouring heights, and had used their horn implements, with their chisel-like edges, to flense the carcass of its load of flesh and blubber, and had carried the spoil to their respective habitations. There can

1 See more particularly Mr. Milne Home's "Ancient Water Lines" (Edinburgh, 1882), and "The Raised Beaches of the Forth Valley," by D. B. Morris (Stirling, 1892).

2 I described this implement in Reports of British Association, 1889, p. 790. It has subsequently been figured in a Report by Dr. Munro in the *Proceedings of the Society of Antiquaries*, 1896.

be little doubt that these implements rank, along with the dug-out canoes, as the oldest relics made with human hands which have up to this time been found in Scotland, and that they belong to the earliest period of occupation by Neolithic man.

After the oscillations in the relative level of land and sea had ceased, and the beach found at the present day had been formed, evidence of the presence of Neolithic man and of mammals, both wild and domesticated, such as now exist in Scotland, becomes greatly multiplied.

Shallow caves or rock shelters situated in the cliff which bounds the esplanade at Oban Bay, which, after being closed for centuries by a landslide from the adjacent height, had recently been quarried into in obtaining stone for building purposes, were described by the lecturer.[1] The caves were as a rule 100 yards inland, and about 30 feet or more above the present high-water mark. They had, no doubt, been formed by the action of the waves at the period of formation of the 25-30 foot beach, for the floor of one of the caves was covered by a layer of gravel and pebbles, which had obviously been washed there when the sea had had access to it.

In these caves, bones representing fifteen human skeletons, men, women, and children were found; also bones of the *Bos longifrons*, red and roe deer, pig, dog, goat, badger, and otter, shells of edible molluscs, bones of fish, and claws of crabs; flint scrapers, hammer stones, implements of bone and horn fashioned into the form of pins, borers and chisel-shaped instruments. In one cave several harpoons or fish spears made of the horns of deer were obtained; similar in form to those found in the Victoria Cave, Settle, in Kent's Cavern, and in the grotto of La Madelaine, France, which in some of these instances have been associated with Palæolithic objects.

An account was then given of the construction and contents of the chambered horned cairns in Caithness and the north-west of Scotland, which have been so carefully investigated and described by Dr. Joseph Anderson ("Scotland in Pagan Times," Edinburgh, 1886). The presence of incinerated bones and of unburnt skeletons showed the cairns to have been places of interment, whilst flint flakes and scrapers, bone and polished stone implements, and shallow vessels of coarse clay, associated them with Neolithic man, obviously the same race as the builders of the English long barrows.

Stone abounds in Scotland, and the polished stone implements which have been found in every county, in the soil and near the surface of the ground, are often of large size, and beautifully ground and polished. Flint, on the other hand, is confined to a few localities, as the island of Mull and limited areas in the counties of Banff and Aberdeen. The nodules are as a rule small in size, and though adapted for the manufacture of arrow-heads and scrapers, flint does not seem to have attained the same importance in Scotland as the raw material provided by nature for the manufacture of articles used by Neolithic man, as was the case in England and Ireland.

Although there is ample evidence of the nature of the implements and weapons manufactured by Neolithic man, and of his methods of interment in rock shelters and chambered cairns, no traces of built dwellings which can be ascribed to the people of this period have been discovered. Doubtless their habitations were constructed of loose stones and turf, and sun-dried clay, or of the skins of animals killed in the chase spread over the branches of trees, which, from their fragile and destructible character, have not been preserved.

In the course of time stone and bone, readily procurable, and which are directly provided by nature for the use of man, gave place to materials which require for their manufacture considerable skill and knowledge. The introduction of bronze as a substance out of which useful articles could be made, marked an important step in human development, and could only take place after men had learnt by observation the ores of copper and tin, and by experiment the methods of extracting the metals from them, and the proportions in which they should be combined in the alloy in order to secure the necessary hardness. So far as Scotland is concerned, bronze must have been introduced from without; its manufacture could not have been of indigenous development, as the ores of tin and copper do not occur in North Britain. Doubtless it came from the southern part of our island, and was extensively employed in South Britain long before it became substituted in the north for the more primitive materials.

[1] For a detailed description, see papers by Dr. Joseph Anderson and the author in *Proc. Scot. Soc. Antiquaries*, 1895.

There is abundant information that Scotland had a Bronze Age. Swords, spears, bucklers, bracelets, rings, fish hooks, axes, chisels, sickles and other implements made of this metal have been found in considerable numbers. These objects occur sometimes singly, at others in collections or hoards in peat mosses, or even at the bottom of lochs and rivers, or buried in the soil as if they had been placed there with a view to concealment, and then, through the death or removal of their owners, had been lost sight of. In many instances these weapons and implements are elegant in design, show great mechanical ability in their construction, and are ornamented with much taste and skill. Instances also are not uncommon in which objects of bronze are found in the sepulchres of the period.

In the study of the Bronze Age in Scotland a want is experienced similar to that felt in a review of the Neolithic period. There are no buildings which can be distinctly regarded as dwelling-places for the men of this time. With them, however, as in the Polished Stone Age, there is evidence of the mode in which they disposed of their dead friends and relatives. Interments which there are good grounds for associating with these people, have been exposed in the formation of roads and railways, and in agricultural operations. Where the surface of the ground has not been cultivated or otherwise disturbed, in almost every county tumuli, mounds, hillocks and cairns occur, the exploration of which has in many cases yielded interesting results. In no instance, however, have chambered cairns, divided into compartments, and possessing an entrance passage, been found associated with articles made of bronze. The sepulchral arrangements of the period possessed a greater simplicity than is shown in the chambered cairn.

The interments in the Bronze Age were sometimes that of a single individual in a knoll or mound, or under a cairn artificially constructed, and now overgrown with grass, heather and whin bushes, or, as is not uncommon, in a collection of sand or gravel near the sea shore, or on a river bank, or in the moraine of some long-vanished glacier. At other times, in similar localities, two to six interments had been made as if in a family burying ground. At others the interments were much more numerous, and represented doubtless the cemetery of a tribe or clan; one of the best known of these was observed some years ago at Law Park, near St. Andrews, in which about twenty interments were recognised. In another at Alloa, twenty-two separate interments were exposed. Quite recently, immediately to the east of Edinburgh, in the districts now known as Inveresk and Musselburgh, not less than fifty interments of this period have been brought to light, in connection with building operations, which implies that then, as now, this part of the country was settled and had a considerable population.

Two very distinct types of interment prevailed, viz. Cremation, with or without cinerary urns; and Inhumation, the unburnt body being enclosed in a stone cist or coffin. From an analysis of 144 localities in Scotland of burials which may be associated with the Bronze Age,[1] and which included about 400 distinct interments, it would appear that in fifty-one of these localities the bodies had all been cremated; in sixty they had been buried in stone cists; in fifteen the same mound or cemetery furnished examples of both kinds of sepulchre, and in the rest the kind of interment was not precisely recorded. These diversities did not express tribal differences, but seemed to have prevailed generally throughout Scotland. Both cremation and inhumation are found in counties so remote from each other as Sutherland in the north and Wigton in the south, in Fife and the Lothians on the east, and in Argyll and the distant Hebrides in the west, as well as in the intermediate districts.

The cremation had been effected by wood fires, for in many localities charcoal has been found in considerable quantity at the place of interment. The heat generated was sufficient to reduce the body to ashes, and to burn the organic matter out of the bones, which fell into greyish-white fragments, often curiously cracked and contorted, which were not very friable. They were then collected and usually placed in an urn of a form and size which we now call Cinerary. When a bank of sand or gravel was convenient, a hole three or four feet deep was made and the urn lodged in it. Sometimes the urn stood erect, and a flat stone was placed across the mouth before the hole was filled in with sand and earth; at others a bed of compacted earth, or of

[1] Most of these are recorded in the "Archæologica Scotica," the *Proceedings* of the Scottish Society of Antiquaries, and Dr. Joseph Anderson's "Scotland in Pagan Times"; whilst others, in the author's note books, have not yet been published.

small stones, or of a flat stone, was made at the bottom of the hole, and the urn, with its contents, was inverted. In some cases the urn was protected by loose stones arranged around it. In obviously exceptional instances, it may be perhaps of a tribal chieftain, a small stone cist was built to enclose the urn, and even a cairn of stones was piled above and around to protect it and to mark the spot.

Cremated interments not contained in urns have been recorded in a few instances, and in them the surrounding sand or gravel has usually been discoloured, from the blackened remains and charcoal having to some extent become diffused through it.

The largest examples of cinerary urns were from 12 to 16 inches in height, with a flat narrow bottom, and 10 to 12 inches wide at the mouth. About one-third the distance below the mouth the urn swelled out to its widest diameter, and was surrounded by one or two mouldings, between which and the mouth the outer surface was often decorated with lines which ran horizontally, or vertically, or obliquely; sometimes they intersected, and formed a chevron or a diamond-shaped pattern. Below the mouldings, the surface was without pattern, though sometimes raised into an additional simple circular moulding.

When the inhumation of an unburnt body was decided on, a rude cist or coffin, formed of undressed flattened stones, was built for its reception. As a rule, the sides and ends of the cist were formed each of a single slab of sandstone, schist, gneiss, granite or other stones provided by the rock in the neighbourhood; but in some instances of a stone of a different character from the adjoining rocks, and obviously brought from a distance. The stones were set on edge and supported a great slab, which, being laid horizontally, formed the lid or cover of the cist, and which was much thicker and heavier than the side and end stones; sometimes, as if for additional protection, a second massive slab was placed on the top of the proper cover. The floor of the cist was formed, when the earth was shallow, of the native rock, and at other times of compacted earth, or a layer of pebbles, or of flat stones. Usually the stone walls and the cover of the cist were simply in apposition, but sometimes they were cemented together with clay. In some cists, exposed a few years ago on the farm of Cousland, near Dalkeith, the peculiarity was observed of the cist being divided in its long direction into two compartments by a stone slab down the middle.

The cists were oblong, the length exceeding the breadth, and although they varied in size, those for adults being larger than for children, they were always shorter than would have been required for a body to be extended at full length. As the end stones were usually set within the extremities of the side stones, the internal measurement of length was some inches less than the external. The average dimensions may be given for the interior about 4 feet in length, 2 feet in breadth, and 2 feet in depth. The cover slab was much larger both in length and breadth, as it overlapped both the sides and ends.

These cists remind one, in their general form and plan, but on a much smaller scale, both as regards the size of the enclosed space and the magnitude of the stones, of the dolmens so frequent in Brittany. As survivals in modern times, we may point to the empty stone boxes, on the cover stone of which an inscription is incised, to be seen in so many country churchyards, built on the ground superficial to the pit in which the body in its wooden coffin has been inhumed.

Owing to the shortness of the cist the body could not be extended at full length, but was laid upon its side, with the elbows bent, so that the hands were close to the face; the hips and knee joints were also bent so that the knees were in front of the body.

Usually only a single skeleton has been found in a cist, either a man or a woman as the case may be. Sometimes two skeletons have been seen, at times a man's and a woman's, doubtless husband and wife; in others the second skeleton has been that of a child. Sometimes the cist was below the average in size, and contained only the skeleton of a child or young person. Such examples throw light upon the family relations of the people of this period. They show that they desired to preserve the associations of kinsfolk even after death; and when the cist contained the remains only of a child it was constructed with the same care as if it had been the tomb of a chief.

When cremated bodies are found associated with stone cists in the same cemetery, the cinerary urns in which the ashes were customarily deposited lie outside the cists, and in quite independent excavations in the soil, but in such close proximity as to show that they belonged to the same period. In two instances short cists have been opened, in which, alongside of the skeleton of an unburnt body, were cremated human bones, not contained in a cinerary urn, but scattered on the floor of the cist, which conclusively prove that both cremation and inhumation were sometimes in practice at the same interment.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. CHARLES E. GREEN, President of the Board of Trustees of Princeton University, died suddenly on December 24.

LAFAYETTE COLLEGE, at Easton, Pennsylvania, suffered serious loss by fire a few days ago for the second time in its history. Pardee Hall, with its valuable collections, was nearly destroyed, and the library was much injured.

Science states that bills have been again introduced into both Houses of Congress to establish the University of the United States. Such a bill was introduced by Senator Edmunds in 1890 and referred to a select committee, which reported unanimously in its favour. The standing committee since appointed has also reported unanimously in its favour, and it is said that the bill will probably be passed during the present session.

AMONG recent appointments are:—Dr. S. Fuchs to be associate professor of physiology at the University at Jena; Prof. Waldemar Lindgren, of the U.S. Geological Survey, to be professor of metallurgy and mining engineering in Stanford University; Mr. Edgar R. Cumings, of Cornell University, to be instructor in geology in the University of Indiana; Dr. W. Ophüls to be professor of pathological anatomy in the University of Missouri.

AN additional chair of Chemistry has been founded and endowed in the McGill University, Montreal, by Mr. W. C. McDonald, who recently erected a new chemical building at a cost of 240,000 dols. The same donor has provided an additional endowment of 50,000 dols. for the faculty of Law, to the deanship of which faculty, with the chair of Roman Law, Mr. F. P. Walton, of the Scotch Bar, was recently appointed. Mr. McDonald has, moreover, supplemented the existing endowments associated with his name by a further gift of 200,000 dols. to provide for any deficiency in income that may result from the fall in the rate of interest on investments.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, December, 1897.—A wet day in a wet district. A remarkably heavy rainfall occurred in the Lake district on November 12. At Skelwith Fold (Lancashire) it amounted to 6·03 inches, or 7·5 per cent. of the annual mean; at Skelwith Bridge (Westmoreland) 6·35 inches were measured, or 7·8 per cent., and at Leathwaite (Cumberland) 8·03 inches, or 6·1 per cent. of the annual mean. There was no thunderstorm, but a continuous pelting rain nearly throughout the twenty-four hours. Naturally, much damage was caused by floods.—Temperature variations in November. An observer at Cheltenham draws attention to some remarkable changes during November 14 to 20, the greatest of which was a fall of 21°·4 between the 18th and 19th. In the neighbourhood of London the greatest difference between any two consecutive readings during November was 19°·6. Mr. Symons points out that nearly similar differences also occurred in 1866 and 1893.—The same number also contains some useful particulars, with illustrations, respecting Richard's instruments for use with kites or balloons. Pressure, humidity, and temperature are simultaneously recorded on a single sheet of paper; the total weight of the instrument is only 36 ounces.

Wiedemann's Annalen der Physik und Chemie, No. 12.—Origin of contact electricity, by C. Christiansen. The gas surrounding a jet of zinc, lead, or tin, amalgam has a marked influence upon its uninterrupted length. Air, oxygen, and sulphurous acid have the effect of retarding the breaking up of the jet, owing to contact electrification. The author measures the length of the continuous jet by making it part of a circuit containing a galvanometer, the steadiness of the needle denoting

the continuity of the jet. He finds that air or oxygen have no effect when quite dry.—Temperature of the electrodes of mercury arc lamps, by L. Arons. In the arc lamp with mercury electrodes, devised by Arons, the anode is the hotter, and gradually distils over into the kathode, which is flickering and turbulent. Mercury is condensed on the walls of the vacuum tube, which are easily obscured.—Deflection of kathode rays, by W. Kaufmann and E. Aschkinass. The authors determined the deflection produced in kathode rays by a narrow field due to condenser plates mounted in a tube crossing the vacuum tube at right angles. They found that the amount of deflection observed is strictly in accordance with the projection hypothesis of kathode rays as against the German wave hypothesis.—Magnetic deflection of kathode rays, by W. Kaufmann. The above result led the author to redetermine the ratio e/m of the charge of the projected particles to its mass, by a close study of the magnetic field deflecting the ray. It was found to be $1 \cdot 77 \times 10^7$ instead of 10^7.—Kathode rays, by E. Wiedemann and G. C. Schmidt. There are two distinct kinds of kathode rays, which proceed from a point in the form of a solid cone and of a hollow cone respectively, producing on the wall of the tube a patch or a ring. The authors studied these two species under the simplest conditions. They placed a knob, forming the terminal of a Lecher secondary wire, against an exhausted glass sphere without electrodes. A hollow cone proceeded from a point in the sphere next to the knob, whose angle varied with the exhaustion, the size of the sphere, and the curvature of the electrode, increasing as they increased.—Electric observations by balloon, by R. Börnstein. The balloon offers the best means of determining the true potential at any point in the atmosphere, but the charge of the balloon itself is a source of error. This may be eliminated by employing three collectors for three successive points below the balloon, and only about 2 m. distant from each other. If the decrease of potential is uniform, the charge of the balloon is zero. Otherwise, the charge is easily calculated from the observed decrements.—Thermodynamics of luminescence, by K. Wesendonck. A luminescent body is capable of imparting heat to a body warmer than itself. This does not contradict the second law of thermodynamics, as luminescence is not ordinary thermal radiation.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 16, 1897.—"The Comparative Chemistry of the Suprarenal Capsules." By B. Moore, M.A., and Swale Vincent, M.B.

In this paper it is shown that the "paired bodies" of Elasmobranch fishes contain the same chromogen as the medulla of the suprarenal capsules of mammals. In previous papers Vincent had shown not only that the "paired bodies" bear a close resemblance histologically to mammalian medulla, but that they contain a substance which constricts arterioles and raises blood pressure in a similar manner to mammalian medulla.

From the chemical point of view Moore had further shown that this active substance is closely associated with a chromogen also found only in the suprarenal medulla. The active material and chromogen are not, however, identical, for the activity may be destroyed without destroying the chromogen by allowing the material to stand for seven to ten days in strong alcohol. Moore hence supposes that the active material has a complex molecule which is decomposed by the alcohol, and that the chromogenic properties are attached to a group in this molecule which is unattacked in the decomposition.

The colour reactions of the chromogen show that it contains an ortho-dihydroxy-benzene nucleus; thus, it gives a deep green coloration with ferric chloride, and reduces silver nitrate in the cold. Besides these tests, it gives a rose-red colour with alkalis and free halogens and other reactions, which show that it is a strong reducing agent.

Using these colour reactions as tests the chromogen was sought for in extracts of the paired bodies of Elasmobranchs (*Scyllium canicula*), and was found to be present in abundance.

It was also shown that no chromogen is present in the inter-renal of Elasmobranchs, which, according to Vincent, corresponds to the cortex of the suprarenal of mammals.

Thus, additional evidence is furnished that the paired bodies correspond to mammalian medulla, while the inter-renal does not resemble medulla and is probably cortex, as suggested by Vincent.

"On a Method of determining the Reactions at the Points of Support of Continuous Beams." By George Wilson, M.Sc., Demonstrator in Engineering in the Whitworth Laboratory of the Owens College, Manchester.

The solution given in this paper differs from those of Bresse, Clapeyron, and Heppel, insomuch that the reactions at the points of support are considered as the unknown quantities to be determined, instead of the bending moments over the piers.

It is shown that by considering the continuous beam as a beam supported at each end and under the action of the given loading acting downwards, and the intermediate supports considered as unknown concentrated loads acting upwards, and equating the deflection at any intermediate point of support caused by the former loading to that caused by the several intermediate reactions treated as concentrated loads, the following series of equations is obtained, viz.:—

$$\begin{aligned} N_1 &= R_1 n_1' + R_2 n_1'' + R_3 n_1''' + \ldots \\ N_2 &= R_1 n_2' + R_2 n_2'' + R_3 n_2''' + \ldots \\ &\text{\&c.} \qquad\qquad \text{\&c.} \end{aligned}$$

Where R with the correct suffix is the reaction at any intermediate point of support, and N and n with their suffixes are quantities depending on the dimensions of the beam and the loading.

The quantities n are constant and need only be determined once, whilst the value of N changes with the position and magnitude of the live load. A method of determining these constants when the cross section of the beam is variable, is given; when the cross section is uniform, the equations can be written down at once.

The elevation or depression of the supports from any cause affects the values of R, the alterations in which can be determined by means of the above equations when the amount of the elevation or depression is known.

An example is appended to show the application of the method.

Geological Society, December 15, 1897.—Dr. Henry Hicks, F.R.S., President, in the chair.—On the Pyromerides of Boulay Bay, Jersey, by John Parkinson. After briefly noticing the literature of the subject, the author described the altered rhyolites of Boulay Bay. One variety, the commonest, is of a dark red colour, showing flow-structure; another is porphyritic; a third, near the centre of the Bay, has a pale greenish matrix enclosing fragments, which, however, are due to flow-brecciation. Large pyromerides occur in two localities: in the more interesting, that north of the jetty, the structure of the rock indicates either a very peculiar magmatic differentiation *in situ* or (more probably) the mixture of two magmas differing in their stage of consolidation. From study of a series of specimens of the pyromeridal rock, the author arrived at the following conclusions: (1) The rock shows marked flow-structure and at times bands which indicate a slight difference in its composition, the latter tending to assume a moniliform outline. In such the microscopic structure corresponds with that of the pyromerides, and exhibits traces of radial crystallisation. (2) These afford a passage into somewhat oval pyromerides, with rather tapering ends and irregularly mammillated surfaces. (3) From these sometimes a single one seems to be thrown off, while lines of pyromerides or little lumps of similar material are scattered about the matrix. (4) Many of the pyromerides are solid throughout; others have a central cavity filled with quartz.—On the exploration of Ty Newydd Cave near Tremeirchion, North Wales, by the Rev. G. C. H. Pollen. In November 1896 a Committee was formed, consisting of Dr. H. Hicks, Dr. H. Woodward, and the author, for the purpose of exploring this cavern, which is situated in the same ravine on the east side of the Vale of Clwyd as the well-known caverns of Ffynnon Beuno and Cae Gwyn, explored about twelve years ago by Dr. H. Hicks and Mr. E. B. Luxmoore. Grants have been made by the Royal Society and by the Government Grant Committee for the purpose of carrying on the explorations; and though a considerable time must elapse before the work is completed, the results already obtained are of importance. The cavern had been in part broken into by quarrying operations, but the chambers and tunnels were completely filled up with more or less stratified deposits, and had remained entirely untouched. Although the ground above the cavern is strewn over with drift and erratics from the north and from the central areas of Wales, not a fragment of anything but immediately local material has

been discovered in the cavern itself, showing clearly that the deposits in the cavern had been carried in by water before the northern and western ice had reached this area. The work has been carried on almost continuously throughout the year, and most of the material has been removed for a distance of over 60 feet from the entrance. The height of the cavern above sea-level is 420 feet, or about 20 feet above the floor of the Cae Gwyn Cave. The following points appear to the author to be now fully established: (1) The material in the Ty Newydd Cave, as in the lower parts of those of Ffynnon Beuno and Cae Gwyn, is of purely local origin. Of this he can speak with confidence, as the question was before him from the beginning and the gravels were examined with minute care for erratics. (2) This local deposit is of earlier date than the boulder clay with western and northern drift. This was proved by the finding of granite- and felsite-boulders abundantly at higher levels and over the cave, and in one case filling the upper part of one of the fissures communicating from above with the cavern. (3) The occurrence of the tooth of a large mammal (*Rhinoceros*) in the lower part of the cave shows that the animal was contemporary with, or of earlier date than the infilling of the cavern by the local drift.

Chemical Society, December 15, 1897.—Prof. Dewar, President, in the chair.—Prof. F. R. Japp delivered the Kekulé Memorial Lecture (see p. 180)—December 16, 1897.—Prof. Dewar, President, in the chair.—The following papers were read:—Stereochemistry of unsaturated compounds. Part i. Esterification of substituted acrylic acids, by J. J. Sudborough and L. L. Lloyd. The authors have made experiments on the esterification of many cinnamic acids and other derivatives of acrylic acid; the acids were boiled under fixed conditions with methylic alcohol solutions of hydrogen chloride, and the quantity of methylic salt formed was subsequently determined. Several rules governing the speed and course of esterification are formulated.—Formation and hydrolysis of esters, by J. J. Sudborough and M. E. Feilmann. The authors conclude that in the conversion of an acid into its ester by the action of an alcohol, either with or without hydrogen chloride, the rate of esterification is determined by two factors, namely (1) the configuration of the acid or the close proximity of substituting groups to the carboxyl group, and (2) the strength of the acid as determined by its affinity constant. The same two factors operate in determining the rate of hydrolysis of the ester.—A new method of determining freezing points in very dilute solution, by M. Wildermann.—A possible basis of generalisation of isomeric changes in organic compounds, by A. Lapworth. The author points out that many isomeric changes, hitherto regarded as of dissimilar types, may be formulated as special cases of a general form, expressible by the reversible equation $R_\alpha M . R_\beta : R_\gamma \rightleftarrows R_\alpha : R_\beta . R_\gamma M$; a labile group M moves from an α to a γ position, the necessary rearrangement of single and double bindings taking place between the three atoms, R_α, R_β and R_γ. By the aid of this general formula and its extended forms the author is able to explain a large number of cases of desmotropy, tautomerism and isomeric change.

DUBLIN.

Royal Dublin Society, December 22, 1897.—Prof. G. F. Fitzgerald, F.R.S., in the chair.—Prof. Thomas Preston read a paper on the radiation of light in a magnetic field. The author described how he had been led to apply photography to the study of the effect (recently discovered by Prof. Zeeman) produced by a strong magnetic field on the radiation from a source of light placed in it. The photographs were projected on a screen, and they rendered all the effects described by Prof. Zeeman clearly visible to a large audience (see p. 173).—Prof. J. Joly, F.R.S., then read a note on a theory of sun-spots. If at some level in the photosphere the temperature falls below the critical temperature of the elements present, and the pressure is sufficient, a precipitation of liquid will result; and it is suggested such a precipitated flood of liquid matter, supported on gaseous matter of higher density, would give rise to the appearances presented by a sun-spot. If the liquid is opaque, it will look darker than the surrounding photosphere. The reflection of the photosphere at the edge and the inrush of gaseous matter over the cooler area will, it is believed, explain the appearance of the penumbra. The re-evaporation of the liquid constitutes the disappearance of the spot. On this view the sun-spot constitutes the first beginning of a change of state in the sun visible to us.

PARIS.

Academy of Sciences, December 20, 1897.—M. A. Chatin in the chair.—The Secretary informed the Academy of the loss it had sustained through the recent death of M. Brioschi, of Milan.—Observations relative to the coffins of Voltaire and of Rousseau, opened December 18, 1897, by M. Berthelot.—Determination of the absolute coordinates of the stars, and also of the latitude, by means of meridian instruments. General method for the solution of these problems, by M. Lœwy.—On the periods of double integrals of algebraic functions, by M. Emile Picard.—Comparison of the thermogenetic or dynamogenetic power of simple food-stuffs with their nutritive value, by M. A. Chauveau. A considerable difference exists between the isoenergetic and isotrophic weights of sugar and fat in the case of a working subject. The isoglycogenetic and isotrophic powers are practically identical.—On those cases of the problem of three bodies (and of *n* bodies) in which two of them collide at the end of a finite time, by M. Painlevé.—On a special method of circumzenithal observations, by M. Ch. Rouget. A further study of the method described in a previous note.—On a particular conjugate net of certain surfaces derived from surfaces of the second order, by M. S. Mangeot.—On Taylor's series, by M. Eug. Fabry.—On the isothermal and adiabatic transformations of true gases; determination of the ratio of the two specific heats, by M. A. Leduc.—On an apparatus permitting of the separation of simple radiations in close proximity, by M. Maurice Hamy. The method is based upon the principle of interference.—Ebullioscopy of some salts in ethereal solution, by M. R. Lespieau. Results are given for uranyl nitrate and the chlorides of mercury, iron, zinc, and antimony.—On cerium, by M. Boudouard. A reply to criticisms on a former paper by the author.—On the duration of the phosphorescent power of sulphide of strontium, by M. José Rodriguez Mourelo. Experiments on sulphide of strontium prepared by different methods show that those specimens which exhibit the greatest intensity of phosphorescence are also those in which the property is most quickly developed and is preserved for the longest time.—Volumetric estimation of antimony, by M. H. Causse. The new method proposed is an iodometric one, depending upon the liberation of iodine from iodic acid by antimonious oxide.—Difference between nitroso-substitution derivatives according as the NO group is directly connected with carbon or with nitrogen, by MM. Camille Matignon and Deligny. A thermochemical paper.—A colour reaction of ordinary aldehyde, by M. Louis Simon. A blue colour is produced on the addition of solutions of trimethylamine and of nitro-prussiate of sodium. The reaction is not given by other aldehydes.—Action of piperidine upon carbonic ethers of phenols; formation of aromatic urethanes, by MM. Cazeneuve and Moreau.—On two Lepidoptera destructive to the sugar-cane in the Mascarene Isles, by M. Edmond Bordage. The author endeavours to clear up the confusion which has arisen as to the history and nomenclature of two species, the larvæ of which are known as "borers."—On the nuclear value of the *central body* of bacteria, by MM. J. Kunstler and P. Busquet.—On extra-liberian cribriform tissue and extra-ligneous vascular tissue, by M. E. Perrot.—On potato rot, by M. E. Roze. An account of the nature and causes of the various changes to which the tubers are liable after gathering.—The composition of oat, wheat, and rye straw, by M. Balland. The results of analyses show no difference between the three varieties of straw, which contain only trifling quantities of nutritive material. Short and leafy straw is to be preferred for the food of horses, and long straw for their litter.—On the presence of beds containing *Planorbis pseudo-ammonius* and *Bulimus Hopei* in the neighbourhood of Sabarrat and Mirepoix (Ariège), by M. G. Vasseur.—Influence of sub-nitrate of bismuth upon the "hardening" of cider, by MM. Leon Dufour and Daniel. The presence of the salt greatly retards the development of acidity. Its addition is recommended in the proportion of 10 grams per hectolitre (0·01 per cent.).—On the estimation of the acidity of urine, by M. H. Joulie. Advantages are claimed for the use of a standard solution of saccharate of lime. No indicator is required, the end-point being shown by the production of a precipitate of phosphate of calcium when the free acid and acid phosphate of sodium have been neutralised.—On the fermentation of cellulose, by M. V. Omelianski. A quantitative study of the action of the ferment described in a previous communication. The products of the decompositions are hydrogen, carbon dioxide, and a large proportion of fatty acids.—Muscular atrophy

experimentally produced by pyocyanic intoxination, by MM. Charrin and H. Claude.—On tubercular sclerosis of the pancreas, by M. Paul Carnot.

December 27.—M. A. Chatin in the chair.—In an obituary notice of M. F. Brioschi, whose recent death was announced at the previous meeting, M. Hermite gave a brief account of the work of that distinguished mathematician.—A special method for the absolute determination of declinations and of latitude, by M. Lœwy. A further development of the subject of the author's previous communication.—The centrosomes in vegetable cells, by M. L. Guignard.—On phthalic green. Constitution, by MM. A. Haller and A. Guyot. The colouring matter previously described is to be considered as a substitution derivative of malachite green. The results obtained by Fischer are explained by the presence of impurities in the materials used by him.—Observation of the shower of Orionids, December 12–14, at Athens, by M. D. Eginitis.—On the existence of integrals in orthoic systems, by M. Riquier.—On surfaces applicable to a surface of revolution, by M. A. Pellet.—On linear functional equations, by M. Lémeray.—On a spring ergograph, by MM. A. Binet and N. Vaschilde. Several advantages are claimed for the use of a spring, instead of a weight, in this instrument.—Conductivity of radio-conductors or discontinued electrical conductivity. Resemblance to nervous conductivity, by M. Edouard Branly.—Magnetic properties of tempered steels, by Mme. Sklodowska Curie.—On the polarisation of the light emitted by a sodium flame placed in a magnetic field, by M. A. Cotton.—On the preparation of alloys of beryllium. Alloys of beryllium and copper, by M. P. Lebeau. The alloys are obtained by heating, in an electric furnace, an intimate mixture of oxide of beryllium, oxide of copper, and charcoal.—On the impurities of aluminium and of its alloys, by M. Ed. Defacoz. The author seeks to determine the form in which the foreign elements (silicon, iron, and copper) exist in the metal.—On a double carbonate of sodium and protoxide of chromium, by M. G. Baugé. The new salt results from the action of a solution of sodium carbonate upon chromous acetate in an atmosphere of carbon dioxide. It crystallises with either one or ten molecules of water and is a powerful reducing agent, decomposing water at 100° C. with evolution of hydrogen.—On the atomic weight of cerium, by MM. Wyrouboff and A. Verneuil. A rejoinder to M. Boudouard's criticism.—On the use of carbide of calcium in the preparation of absolute alcohol, by M. P. Yvon. Pure alcohol is without action upon calcium carbide, but the presence of even traces of water leads to the evolution of acetylene and formation of calcium hydrate. It is therefore possible by one, or at most two, distillations to prepare absolute alcohol from spirit of 90 per cent. strength.—On the aromatic diurethanes of piperazine, by MM. P. Cazeneuve and Moreau.—On α-acetylfurfurane and its presence in wood-tar, by M. L. Bouveault.—On the behaviour, on distillation, of a mixture of pyridine with propionic, acetic, and formic acids. The author has studied the progress of fractionation in the case of mixtures of a volatile acid with a feeble base. In the case of pyridine and formic acid the former begins to distil over in a nearly pure state, although its boiling point is 14° higher than that of formic acid.—On crystalline minerals formed under the influence of volatile agents at the expense of the andesites of the island of Thera (Santorin), by M. A. Lacroix.—The theory of the sense of orientation in animals, by M. G. Reynaud.—On the generation of leucocytes in the peritoneum, by M. J. J. Andeer.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 6.

ROYAL INSTITUTION, at 3.—The Principles of the Electric Telegraph: Prof. Oliver Lodge, F.R.S.

FRIDAY, JANUARY 7.

GEOLOGISTS' ASSOCIATION, at 8.—A Brief Account of the Excursions in the Urals, down the Volga, in the Caucasus, &c., made in connection with the International Geological Congress held in Russia, August–September, 1897: L. L. Belinfante.

SATURDAY, JANUARY 8.

ROYAL INSTITUTION, at 3.—The Principles of the Electric Telegraph: Prof. Oliver Lodge, F.R.S.

TUESDAY, JANUARY 11.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Machinery used in the Manufacture of Cordite: E. W. Anderson.
ANTHROPOLOGICAL INSTITUTE, at 8.30.
RÖNTGEN SOCIETY, at 8.30.—Practical Work with the X-Rays: W. Webster.
ROYAL VICTORIA HALL, at 8.30.—Diamonds: Prof H. A. Miers, F.R.S.

THURSDAY, JANUARY 13.

MATHEMATICAL SOCIETY, at 8.—Note on a Property of Pfaffians: H. F. Baker.—On the Stationary Motion of a System of Equal Elastic Spheres of Finite Diameter (continuation): S. H. Burbury, F.R.S.—On Discontinuous Fluid Motion: B. Hopkinson.—On the Intersections of Two Conics of a given Type, and on the Intersections of Two Cubics: H. M. Taylor.—On the Continuous Group defined by any given Group of Finite Order: Prof. W. Burnside, F.R.S.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Presentation of Premiums.—Inaugural Address of the President, Joseph W. Swan, F.R.S.

FRIDAY, JANUARY 14.

ROYAL ASTRONOMICAL SOCIETY, at 8.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Mechanical Draught: R. Gordon Mackay.
MALACOLOGICAL SOCIETY, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Span of Gestation and the Cause of Birth: Dr. J. Beard (Jena, Fischer).—Die Farnkräuter der Erde: Dr. H. Christ (Jena, Fischer).—Lehrbuch der Vergleichenden Mikroskopischen Anatomie der Wirbeltiere: Dr. A. Oppel, Zweiter Teil, Schlund und Darm (Jena, Fischer).—Annuaire de l'Observatoire Municipal de Montsouris, 1898 (Paris, Gauthier-Villars).—Alembic Club Reprints, Nos. 13 and 14 (Edinburgh, Clay).—Imperial University of Japan, Calendar for 1896–97 (Tōkyō).—Sixteenth Annual Report of the Bureau of American Ethnology (Washington).—Knowledge, Vol. xx. (Witherby).—Tables of Parabolic Curves: G. T. Allen (Spon).—Gesammelte Kleine Schriften: L. Rütimeyer, 2 Vols. (Basel, Georg).

PAMPHLETS.—National Association for the Promotion of Technical and Secondary Education, Tenth Annual Report (London).—A New Theory of the Stars: Prof. A. W. Bickerton (Christchurch, N.Z., Whitcombe).—La Planète Vénus: C. Flammarion (Paris, Gauthier-Villars).—Periodic Orbits: Prof. G. H. Darwin.

SERIALS.—Bulletin of the Illinois State Laboratory of Natural History, Vol. 5, Article 3 (Urbana, Ill.).—Humanitarian, January (Hutchinson).—Contemporary Review, January (Isbister).—Maori Art, Part 2: A. Hamilton (Wellington, N.Z.).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1897, Part 2 (Philadelphia).—Fortnightly Review, January (Chapman).—Journal of the Royal Horticultural Society, December (117 Victoria Street).—Journal of the Royal Agricultural Society, Vol. 8, Part 4 (Murray).—Plankton Studies on Lake Mendota, II.: Prof. E. A. Birge (Wisconsin).—National Review, January (Arnold).—Reliquary and Illustrated Archæologist, January (Bemrose).—American Journal of Mathematics, January (Baltimore).

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THURSDAY, JANUARY 13, 1898.

A SYSTEM OF MEDICINE.

A System of Medicine. By many Writers. Edited by Thos. Clifford Allbutt, M.A., M.D., F.R.C.P., &c., Regius Professor of Physic in the University of Cambridge. Vol. iii. Pp. xi + 1001. Illustrations 23. Charts iv. Plate i. Vol. iv. Pp. xii + 880. Illustrations 31. Plate i. (London: Macmillan and Co., Ltd., 1897.)

THE works before us are the third and fourth volumes of Prof. Allbutt's "System of Medicine," the first and second volumes of which have been already reviewed in these columns.

Vol. iii. begins with a consideration of the General Diseases of Obscure Causation. The subject is introduced by an article on Acute Rheumatism, or Rheumatic Fever, which is contributed by Dr. Church. This article contains a mass of clinical information drawn from a rich bibliography, and supplemented by the author's own ample experience at St. Bartholomew's; as an instance of the latter, we may mention a chart of 1998 cases of rheumatic fever arranged in months according to the time of onset of the disease. Acute Rheumatism in children is dealt with by Dr. Cheadle, and forms a valuable addition to the above article. The very various manifestations of acute rheumatism in children are described, and the relative sudsidiary importance of the arthritic phenomena is emphasised. Rest and full alkaline treatment are, according to the author, the most valuable therapeutic measures in diminishing the frequency of the occurrence of cardiac inflammation.

The articles on Chronic Rheumatism, Gonorrhœal Rheumatism, and Muscular Rheumatism are from the pen of Dr. A. E. Garrod. The essay on Rheumatoid Arthritis is contributed by Dr. Kent Spender, of the Royal Mineral Water Hospital, Bath; unfortunately, before its completion he had to relinquish the task. The revision, however, fell into fortunate hands, and was undertaken by Dr. A. E. Garrod, who entirely contributes the section on treatment. Rheumatoid arthritis in children forms the subject of a special essay by Dr. Still. The monograph on Rickets is written by Dr. Cheadle, and includes a full description of the disease, an account of its pathology and treatment, and of its modifications and concurrent disorders. Mr. Bowlby contributes three succinct articles on Mollities Ossium, Acromegaly, and Hypertrophic Pulmonary Osteo-arthropathy.

All will agree that the essay on Gout could not have fallen into better hands, coming as it does from the pen of Sir William Roberts. The author expresses the views so clearly enunciated by him in the Croonian Lectures for 1892, with regard to the existence and decomposition of the so-called quadri-urates. The relative merits of the mechanical and chemical theories of the production of the symptoms of gout are carefully examined. The monograph concludes with a consideration of the general and local treatment of gout. Dr. Saunby contributes the article on Diabetes Mellitus; the late Dr. Ralfe the one on Diabetes Insipidus. This part of the volume concludes with an essay on Lardaceous Disease by Dr. Howship Dickinson.

The second division of the work is devoted to diseases of Alimentation and Excretion. Two essays on the general pathology of Digestion and Secretion introduce the subject. In the former, Drs. Ralfe and Soltau Fenwick give an account of what may perhaps not inappropriately be termed the clinical chemistry of digestion, and describe the more recent methods for the qualitative and quantitative determination of the various constituents—normal and pathological—of the digestive juices, more especially, of course, of the gastric juice. It is to be wished that the value of exact chemical examination of the gastric contents after test meals should be more recognised in this country. The general Pathology of Secretion is the subject of a short essay by Dr. Rose Bradford. The pathological modifications, both in quality and quantity, of external and internal secretions are considered. Shock and Collapse is treated in an original manner by Dr. Cobbet; Diseases of the Mouth by Dr. Wills, and Diseases of the Œsophagus by Dr. Rolleston.

The Diseases of the Stomach are treated by several authors. Among the monographs composing this subsection of the work may be mentioned the essays on Dyspepsia and Gastritis, by Dr. Lauder Brunton. These articles contain a mass of valuable clinical information, and many useful hints for the treatment of these disorders. They are written in that clear and lucid style which is characteristic of their author. Dr. Stocker contributes a short account of Sea-sickness. He divides the treatment of this most unpleasant disorder into preventive and remedial. Under the former head he advises light diet and purgation before starting. He regards the beneficial action of the bromides as most probably due to the anæsthetic action which they exert on the pharynx and larynx, and suggests that they would probably be as efficacious if given as gargles. The Editor writes an account of Mountain-Sickness. He adopts the view that the symptoms are due to the diminished oxygen tension obtaining at high altitudes. Prof. Allbutt further contributes the essays on Neuroses of the Stomach and Gastrectasis. In the former article the author gives an account of the recent researches of Pawlow upon the nervous mechanisms influencing gastric secretion. He then passes to the symptoms of the many varieties of gastric neuroses. Motor Disorders of the stomach are dealt with, and the article concludes with an account of the neuroses of the other abdominal viscera. The article on Gastrectasis comprises a discussion of the ætiology, varieties, diagnosis and treatment of this disease.

The essay on Ulcer of the Stomach is written by Dr. Dreschfield. The author first gives a brief account of the history of this affection, he then passes on to the ætiology, considering the *rôle* played in its production by sex, age, race, climate, occupation, &c. The discussion of symptomatology is very full, and includes a mention of Acetonuria and Diaceturia. The complications and sequelæ are fully considered, as is the diagnosis, prognosis and treatment. Duodenal Ulcer forms the subject of a short appendix to the above article. An able monograph on Tumours of the Stomach is from the pen of Dr. Hale White. Short accounts of Subphrenic Abscess and Diaphragmatic Hernia are given by Dr. Lee

Dickinson. A succinct essay on Abdominal Diagnosis from a Gynæcological point of view is contributed by Dr. Playfair. Enteroptosis is treated by Mr. Treves. The normal mechanism of the suspension of the various abdominal viscera is first considered, and then the displacements undergone by the viscera severally are discussed. The commonest of all these conditions, viz. movable kidney, is reserved for a future article. The author then passes on to general ptosis of the abdominal viscera or Glenard's disease. Its results and treatment are described and illustrated by three well-marked cases.

The next section of the book is devoted to diseases of the Peritoneum; it begins by an article on Acute Peritonitis, which is written by Mr. Treves. After a few pregnant general considerations the author proceeds to enumerate the chief varieties of peritonitis classified according to their cause. A table of 100 cases of peritonitis from the records of the London Hospital is given. The symptoms are next discussed, and numerous temperature charts appended. The course, termination, and prognosis of the disease are then considered, and the article closes with a clear enunciation of the lines of treatment, operative or medicinal, to be adopted. The remaining part of this section is written by Dr. Allchin. The author first directs his attention to Acute Peritonitis of Undetermined Nature. Simple Chronic Peritonitis is then dealt with, subsequently Tubercular Peritonitis, and finally New Growths of the Peritoneum. From the brief sketch given above it will be obvious that the whole subject is very thoroughly treated, and that all of interest to the physician finds very ample consideration.

The concluding division of the volumes is devoted to Diseases of the Bowels. The subject is opened by an essay from the pen of Dr. Lauder Brunton on the Physiology of Fæcal Evacuation and Constipation. The author considers fully the connections between the central nervous system and the intestines, and discusses the influence of emotions upon intestinal peristalsis. Under the head of Constipation Dr. Brunton discusses its causes and treatment, position playing an important part, relief from habitual constipation being occasionally obtained by advising the patient to defæcate in the crouching position. The essay on Diarrhœa is from the pen of the same author, and forms an admirable study of the subject. Dr. Rolleston contributes an article on Diseases of the Small Intestine, and Dr. Hale White a short monograph on Colic. The editor has done well to entrust a special article on the Diarrhœas of Children to Dr. Eustace Smith; this, for the general practitioner, most important subject, is exhaustively treated by the author, who, from the fulness of his clinical experience, handles the subject of treatment especially well. Sprue or Psilosis is well treated by Dr. Patrick Manson.

Mr. Frederick Trevers writes an account of Intestinal Obstruction; physicians will find this essay most useful for reference. It is very full, and well classified, so that the reader can easily find what he wants. The essay on Perityphlitis, or Peritonitis localised in the region of the Cæcum, is from the pen of the same author, and forms a complete clinical study of the subject. A carefully written monograph, by Dr. Hale White, upon Diseases of the Colon, and a short note on the Differential Diagnosis of Diseases of the Rectum and Anus, by Mr. Allingham, conclude the volume.

Vol. iv. opens with a section on Diseases of the Liver. This subject is introduced by four monographs of general interest on the Anatomy and Physiology of the Liver, Congestion of the Liver and Jaundice by Dr. William Hunter. The same author subsequently contributes special articles on Toxæmic Jaundice, Weil's Disease, and Acute Yellow Atrophy. Dr. Hale White writes a succinct account of Perihepatitis and Hepatic New Growths. The difficult medico-surgical subjects of Diseases of the Gall Bladder and Bile-Ducts and Cholangitis are ably handled by Mr. Mayo Robson. The great progress which has of late been made in the treatment of these affections will render Mr. Robson's article, which is quite up to date, of especial value to physicians. We find it odd, however, that no mention should be made in the bibliography of a book recently written upon this subject by Mr. Waring. The section concludes with an essay on Diseases of the Pancreas by Dr. Fitz.

The second division of the volume is devoted to Diseases of the Kidneys. Dr. Rose Bradford writes a complete essay on the General Pathology of the Renal Functions. The first part of the essay is devoted to abnormalities in the urine and their detection. The second part concerns itself more especially with the General Pathology of Renal Disease, in which are comprised a short discussion of Dropsy and Uræmia. Prof. Alexander Macalister contributes an article on Nephroptosis, or Moveable Kidney, to which is appended a rich bibliography. Dr. Howship Dickinson writes a complete essay upon Diseases of the Kidney characterised by Albuminuria. The Diseases of the Kidney which admit of surgical treatment form the subject of a comprehensive article by Mr. Henry Morris.

The third division of the volume occupies itself with the Diseases of Lymphatic and Ductless Glands, in which are included Diseases of the Thyroid Gland, the Spleen, Supra-renal Bodies, Hodgkin's Disease, and Scrofula. This section concludes with a monograph on Obesity by Sir Dyce Duckworth. The article contains a discussion of the various methods of treatment adopted in obesity, such, for instance, as Banting's, Salisbury's, Oertel's, &c., and a useful dietary adopted by the author in his own practice.

The fourth part of the book is devoted to Diseases of the Respiratory Organs, and comprises articles by Dr. Ransome on the General Pathology of Respiratory Diseases, and the Treatment of Asphyxia, and one on Physical Signs of Diseases of the Lungs and Heart by Dr. Hector Mackenzie. The volume concludes with a section on Diseases of the Nose, Pharynx, and Larynx. The articles in this last section are from the pen of nose and throat specialists, and include contributions by Sir Felix Semon, Dr. Watson Williams, Dr. Greville Macdonald, and Dr. de Haviland Hall.

The editor and his collaborators are again to be congratulated upon these further fruits of their labours. To compare one volume of the system with another would be idle. The impression of the reviewer is, however, that the present volumes, if rather less academic than their predecessors, fulfil to a remarkable degree the wants of the student and practitioner of medicine. F. W. T.

ELECTRO-CHEMISTRY.

The Elements of Electro-Chemistry, treated Experimentally. By Dr. Robert Lüpke. Translated from the second, revised and enlarged edition by M. M. Pattison Muir, M.A. Pp. xv + 223. (London: H. Grevel and Co., 1897.)

THE parts of electro-chemistry dealt with in this book are the electrolysis of liquids, the theory of solutions and of osmotic pressure, and the theory of the galvanic battery. We gather from the preface that the main object of the book is to give a description of a number of experiments which illustrate the most important laws of the subject. We think that the author has been successful in this respect, and that the book will prove useful to teachers of physical chemistry. For the experiments described in this book are essentially lecture experiments; they are arranged not so much with the object of getting the greatest possible accuracy, but by means of simple apparatus to give striking illustrations of the points under discussion in the time available in a lecture. The experiments are described in sufficient detail to enable any one to repeat them without difficulty, and seem well adapted for the purpose for which they are intended. When, however, we leave the description of the experiments and come to the conclusions which the author draws from them, the book seems to us to be much less satisfactory; the statements are sometimes obscure, and occasionally erroneous. In the chapter on Faraday's laws of electrolysis the text seems to imply that the amount of salt electrolysed by a given quantity of electricity depends upon the time the electricity takes to pass through the electrolyte. The statements are on pp. 34 and 35, and occur in the definition of what the author means by the expression "electrochemical equivalent." This is quite different from the ordinary meaning of the term electro-chemical equivalent of a substance. In this book the electrochemical equivalent is not, as hitherto, the number of grammes of the substance separated by the passage through the electrolyte of one unity of electricity, but the number of units of electricity required to separate the formula weight in grammes of the substance. We think that nothing but confusion can come from using the old expression in this new sense. This, however, is not the worst; for in defining this quantity the author says "the electrochemical equivalent—that is to say, the number of coulombs which causes the separation in *one second* [the italics are ours] of that fraction of the atomic weight of the metal or of the formula weight of an anion group which corresponds with a single valency." Of course the allusion to one second is quite misleading; the statement would have been equally true if one century had been substituted for one second. The point is unfortunately emphasised by the translator, who has a footnote to the effect, "the statement in the text may be put thus: the electrochemical equivalent is the number of coulombs that causes the separation of a gramme equivalent of a metal or anion group in one second." To make matters worse the following numerical example is given:

"Supposing that 20 c.c. hydrogen and 10 c.c. oxygen were obtained in an apparatus for electrolysis of water in three minutes, this is equal to the production of ·1667 c.c. explosive gas per second, and therefore the quantity of electricity was ·1667/·174; that is ·958 coulomb."

We have devoted some space to this point because it is one about which students are apt to fall into error, even when it is not suggested to them by the text-books. It is only fair, however, to say that the other chapters are much better than the one on Faraday's law. The chapter on the resistance of electrolytes is clear: it would have been more complete if it had contained an account of Mr. Whetham's experiments on the velocity of the ions. By a misprint the student, when determining the resistance of an electrolyte, is directed to adjust the resistances until the telephone sounds. In the chapters on osmotic pressure we have a clear account of the methods of preparing the semi-permeable membranes of ferro-cyanide of copper. In connection with this subject we may remark that it would be interesting to have brought together all the various experiments made on the freezing and boiling points of organic solutions, so as to see how great, if any, are the divergencies from the strict accuracy of the law that substances in solution exert, as osmotic pressure, the same pressure as that which they would exert if they were to occupy as gases the same volume at the same temperature.

A large portion of the latter part of the book is taken up with the discussion of the theory of the galvanic cell; this is generally clear, and the experiments as usual are good and well described. It would be well, however, to discriminate in the theory of the potential difference between a metal and a solution of the salt of the metal between what is derivable from the theory of osmotic pressure and what is the result of further assumption. The theory shows that π this potential difference is expressed by an equation of the form

$$\pi = -a\theta \log \omega + C$$

where θ is the absolute temperature, a a constant, ω a quantity proportional to the osmotic pressure of the action in the solution, and C a quantity of which all that is known about it is that it is independent of the strength of the solution, to write the expression in the form

$$\pi = a\theta \log \frac{P}{\omega}$$

as is done in the text, is to assume that this constant is proportional to the absolute temperature, an assumption which ought to be justified by a series of experiments at different temperatures. We have no hesitation in recommending the book to teachers of physics, though we think it a somewhat dangerous book to put in the hands of a student at the commencement of his studies in electro-chemistry.

OUR BOOK SHELF.

The Foundations of Scientific Agriculture. By Samuel Cooke, M.A., F.I.C., F.G.S. Pp. ix + 268. (London: Longmans, 1897.)

THE author is a Professor in the College of Sciences at Poona; his book contains the matter of a short course of lectures which he has been in the habit of delivering to a mixed class of students. In the course of 260 pages he treats of meteorology, mineralogy, rocks, soil, plant morphology, Indian crops, manures, implements used in cultivation, and mensuration. There is besides a scheme of qualitative analysis, a glossary of terms, and 129

examination questions. The book is written with ability and vigour, and evidently with a keen appreciation of the special needs of India. A full discussion of any subject in the brief limits to which the author confines himself is, of course, quite impossible, but enough is done to arouse interest and inquiry, and this apparently is the author's object. One paragraph we must quote. Alluding to the present effect of Government education in India, namely the withdrawal of the educated classes from agricultural pursuits, he says: "The first great step in renovating the profession of agriculture must come from the introduction of rational systems of national education. Governments must needs rectify their educational codes so as to give greater encouragement to studies tending to the enlightenment of rural populations in regard to food production and the relation of the science of rural economy thereto, combined with systematic demonstrations of economical methods of applying science to agricultural practice." This advice is equally needed in our own country. R. W.

The Zoological Record. Volume the Thirty-third; being Records of Zoological Literature relating chiefly to the Year 1896. By J. A. Thomson, R. Lydekker, R. Bowdler Sharpe, G. A. Boulenger, W. A. Herdman, B. B. Woodward, A. W. Brown, D. Sharp, Florence Buchanan, R. T. Günther, and R. von Lendenfeld. Edited (for the Zoological Society of London) by David Sharp, M.A., F.R.S., F.Z.S., &c. Pp. 890. (London: Gurney and Jackson, 1897).

GREAT credit is certainly due to the zoologists for the way in which they keep up their "Record," and for the punctual manner in which the annual volume is brought out. The zoological literature of 1896, which has appeared in various works, memoirs and periodicals all over the world during that year, has been already investigated and abstracted by these diligent recorders, and the summary of it appears in the present volume, the preface of which is dated in September last, and which was actually issued to the public in November. In no other branch of science, so far as we know, has a "Record" been kept up for so long a period, or issued so nearly up to date.

Besides eighteen records relating to as many branches of zoology, the present volume contains a very useful alphabetical list of the journals and other periodicals that contain zoological papers. This is arranged according to the abbreviated titles by which the journals are quoted in the various "Records," but the full titles are also added, so that we have here a complete and most useful catalogue of zoological periodicals. We have not counted their number, but the list takes up about forty-two closely printed pages, so that if we reckon them at a thousand we shall not be much over the mark. Besides analysing the separate publications referring to his particular subject, the unfortunate recorder may, therefore, have nearly a thousand periodicals to consult, in order to collect together the fragments relating to his particular subject. So great being the field of work in zoology alone, it is difficult to over-estimate the extent of the task about to be undertaken by the Royal Society of preparing an annual record of the literature of all branches of science.

As regards the individual records in the present volume, we observe with regret that several of them are without any sort of introduction. It is obvious, as we pointed out last year, that an introduction, specifying the principal points in which an advance has been made in the particular subject, is a necessary part of a good record. Such an introduction would be read with interest by many zoologists, who do not require to go into details very deeply—and should on no account be omitted. Considerable care and time is, no doubt, involved in its preparation; but we trust that Dr. Sharp, who in this respect himself sets an excellent example as regards the Insecta, will not allow any of his "recorders" to shirk this part of their task, however unwilling he may be to add to their arduous duties.

Annuaire pour l'An 1898, *publié par le Bureau des Longitudes.* Pp. 613 + 147. (Paris: Gauthier-Villars et Fils.)

Annuaire de l'Observatoire municipal de Montsouris pour l'Année 1898. Pp. 636. (Paris: Gauthier-Villars et Fils.)

THESE two year-books of scientific information annually increase in value by the addition of new data and revision of the old. The *Annuaire* of the Bureau of Longitudes has undergone several changes. In the astronomical part the tables of mean positions of stars supposed to be variable have been omitted, the tables of the elements of minor planets have been curtailed, and in the same way the number of coordinates referring to the orbits of double stars has been diminished. The table of elements of periodic comets only observed at a single apparition has been transferred to the *Connaissance de Temps*, but comets observed at a return are retained in the volume. The chapter on tides has been rearranged and revised, and new tables inserted. M. Moureaux contributes three new charts showing the magnetic elements in France, based on direct observations; the charts are for the epoch January 1, 1896. M. Berthelot brings up to date the tables in the section on thermo-chemistry. The articles in the *Annuaire* are all interesting. MM. Lœwy and Puiseux contribute a paper on recent progress in the knowledge of the lunar surface, obtained by means of photography; M. Poincaré contributes a valuable paper on the stability of the solar system; an account of Fizeau's scientific work is given by M. Cornu; and M. Janssen describes the work done at the observatory on the summit of Mont Blanc in 1897. Finally, there is an address by MM. Janssen and Lœwy, delivered on the occasion of M. Faye's jubilee last January.

The *Annuaire* of the Municipal Observatory does not cover so wide a field as that of the Bureau des Longitudes. It contains the results of observations made, during 1896, in the departments of meteorology, chemistry, micrography, and hygiene under the control of the Municipal Council of the City of Paris. In each of these branches, and especially in the sections of chemistry and micrography, a large amount of work was done beyond the mere compilation of statistics, and the volume is thereby rendered serviceable to all who are interested in the science of public health.

Mémoires de la Société de Physique et d'Histoire naturelle de Genève. Tome xxxii. Seconde Partie. Pp. lxxxi + 401. (Genève: Georg et Cie. Paris: G. Fischbacher, 1896-97.)

THERE are five papers in this volume, illustrated by fourteen plates and numerous figures in the text. In a long memoir, Mlle. C. Schépiloff describes her researches on the nerves of the labyrinth or internal ear, and the functions of the brain and medulla of frogs, with a general comparison of the central nervous systems of various batrachians. A demonstration of a fundamental theorem referring to the primitive factors of prime numbers is developed by M. Ch. Cellérier. Anatomical researches on a number of plants are described by M. J. Briquet. M. P. de Loriol describes some echinoderms, and M. J. Briquet makes a contribution to a flora of Paraguay.

Elementary Practical Physiography. (Section I.) By John Thornton, M.A. Pp. vii + 311. (London: Longmans, Green, and Co., 1897.)

THE elementary stage of the physiography examination of the Department of Science and Art is now divided into two parts, the first part (Section One, as it is termed)

dealing with the fundamental principles of physical science, and the second with physical geography as it is generally understood. The complete syllabus thus provides the outlines of an elementary course of general science. Mr. Thornton's book has been written upon the lines of the first part of the syllabus, and therefore it is limited to brief treatment of the elementary facts and principles of physics and chemistry. A large number of experiments are included, some of them good. The illustrations are also numerous, and some of them are original.

The Wealth and Progress of New South Wales, 1895-96. By T. A. Coghlan. Vol. i. Ninth issue. Pp. 491. (Sydney: Government Printer, 1897.)

THE difficulty in preparing a volume of this kind is to limit the information concerning the details of local affairs, and yet make them useful both locally and to the outside world interested in the features and progress of our colonial possessions. Mr. Coghlan, the Government Statistician of New South Wales, seems to have successfully adjusted the balance of the two interests, with the result that his volume appeals to all who wish to have accurate information concerning the active life of the Colony. Moreover, there are chapters on the history of the Colony, the climate, geological structure, physical configuration, fauna, flora, forestry and fisheries, and mines and minerals. The volume will be very serviceable for reference.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Glacial Period and the Irish Fauna.

IT has been shown by the work of many observers, in Scotland, Ireland, north-western England and the Isle of Man that during the Glacial Period the basin of the Irish Sea must have been filled with an ice-sheet. It is not probable, therefore, that the interesting speculations of Dr. Scharf on the origin of the Irish fauna (NATURE, October 28, 1897), in so far as they are based upon assumptions as to the glacial conditions of the Irish Sea, will meet with much acceptance among geologists.

There is one possible mode of migration for land-animals in formerly glaciated regions which I think has been too frequently ignored by students of the subject. I refer to the probability that the ice-sheet itself may have furnished a practicable route across narrow seas. In Prof. I. C. Russell's luminous description of the Malaspina Glacier of Alaska, we read that "a broad game-trail which had evidently long been used by bears, wolves, foxes and mountain-goats," skirting the Chaix Hills, "continued across the glacier 6 or 8 miles north-eastward to the Samovar Hills." Again, Dr. Scharf himself incidentally mentions that in Northern Europe "it is a well-known fact that reindeer are in the habit of travelling considerable distances on ice."

During my recent survey of the Isle of Man I have found abundant evidence to show that during the maximum glaciation an extraneous ice-sheet swept across the highest summit (2034 feet), and also that during the closing stages of the Glacial Period this ice-sheet melted away more rapidly in the vicinity of the island than in the surrounding obliterated sea-basin. Under such conditions the island formed a nunatak accessible for any animal which could cross the ice. And I think that the general circumstances attending the close of the Glacial Period indicate that most of the land surrounding the enclosed sea-basins in our latitudes might be in a condition to support animal life before the decaying ice-lobes had disappeared from these hollows. During the earlier stages of the Glacial Period it is clear that the climate was such as to favour the accumulation of glaciers even at sea-level, and this condition persisted until ice-sheets of great thickness had covered the lowlands. This growth at length ceased; perhaps, as I have elsewhere suggested, in the east sooner than in the west, because of the greater amount of snowfall along the western periphery of the sheet.

In the northern part of the Irish Sea basin there existed a high plateau of ice, its surface probably not far, if at all, short of 3000 feet above present sea-level. An amelioration of climate set in, and progressed until, say, no permanent snow was possible at any altitude under 1000 feet. But the ice-sheet was already in possession, and by reason of its elevation would remain, throughout the greater part of its area, uninfluenced by this extent of change, or it might even still continue to grow where there was sufficient precipitation. In an ice-choked basin hemmed in by hills as is the Irish Sea, the discharge by flow alone was scarcely likely to keep pace with the surface accumulation.

Not until the climate became such that melting was in progress over the whole plateau would there be much general lowering of its surface. Under such conditions, as the elevation of the ice-sheet was equal to, or greater than, the uplands upon which it abutted, the snowfall could no longer remain permanently, even on the hilly ground. Hence, as the land emerged from its icy covering, it would remain bare, and ready to support vegetation. As on the Malaspina Glacier, even the ice itself, where covered with morainic débris, might become verdure-clad.

The melting influence of rain falling upon the ice-sheet would be distributed equally over the recipient surface, for its superfluous heat would be at once absorbed. But whatever rain fell upon the emerging land could gather and flow in comparatively warm streams, capable of exerting a considerable differential effect where they impinged upon the margin of the ice. There would thus be a general tendency for the melting mass to shrink down more quickly in the vicinity of land; and this effect would be accelerated as the lower levels were uncovered.

These are the conditions disclosed by the field evidence in the Isle of Man, and that life existed under such conditions is proved by the presence, in one of the gravel-terraces of this period, of the arctic fresh-water crustacean *Lepidurus* (*Apus*) *glacialis*, which lives now in icy pools near glaciers in Norway and Spitsbergen, along with an arctic willow, *Salix herbacea*, and a few other plants of wider range.

The Irish Elk reached the Isle of Man about this time, and I think it probable that it crossed from the mainland on the waning ice-sheet. The evidence is altogether unsatisfactory for a Post-Glacial land-connection, as Mr. P. F. Kendall has shown.

The distance between the nearest points of Ireland and Scotland is about the same as between the nearest points of the Isle of Man and Scotland, and I see no reason why certain elements of the Post-Glacial fauna of Ireland should not have been similarly introduced by the ice-bridge. At any rate, in view of the above-quoted data furnished by the Alaskan Glaciers, this appears to me to be a legitimate supposition, and one which is in keeping with the general trend of the geological evidence.

G. W. LAMPLUGH.

The Variability of Mira Ceti.

THE notes in NATURE, December 2 and 9, are very welcome, as they show more interest in *o* Ceti than in late years, and especially as from present information there have been but few observations from this side on the recent appearance. It seems that I have seen, so far, more of the star than any one else.

The maximum of Mira, following previous ephemerides, was due October 1. But *The Companion* and Chandler have added a correction of about forty days, and given the date as November 9. This phase appears to have occurred this season November 30, which is sixty days late. But it is not at all improbable that another maximum may be observed, although the star seems now to have broken away definitely. It was a step or so brighter than a star (3·99 H.P.) last night, and is unchanged to-night except in colour. Its reddish cast to-night, judging from some past experiences, indicates a change in light, and another rise may occur.

The magnitude November 30 was 3·2, Gamma Ceti being 3·59 Harvard measurement.

It is remarkable that while there is agreement as to the light-curve of Mira for three years, the dates of maximum are as much as five weeks apart. But there still remains some doubt as to the fluctuations in 1894-95; and did not Mr. H. M. Parkhurst confirm the present writer's observations of that apparition, they would have been thrown out of court. And some doubt would attach to Mr. Parkhurst's did not an observer at Moscow, mentioned in NATURE, confirm both of us. DAVID FLANERY.

Memphis, Tenn., U.S.A., December 24, 1897.

RECENT SEISMOLOGY.

I.—EARTH MOVEMENTS WHICH WE FEEL.

THE circumstances which led to the recent advances in seismological science are closely connected with an earthquake-like reformation in the policy of a foreign country. The country referred to is Japan, and the story of the changes it so suddenly effected is well known.

To bring about the new conditions engineers, architects, doctors, lawyers, surveyors, literati generally, together with representatives of a variety of trades, were invited to the birth of a new *régime*.

The engineers built their bridges, but found that they were shaken down; architects were disheartened that their houses were unroofed and subjected to processes of shattering; doctors learned that seismic disturbances might be followed by nervous prostration, tetanus and erysipelas; lawyers were perhaps perplexed when their opinion was required respecting the ownership of superimposed properties; the surveyors saw that the area of a piece of ground was not necessarily a constant quantity, and that gate-posts, on which bench-marks had been placed, might change their position by hopping—in short, one and all were impressed by the mobility of their near surroundings, and were often alarmed by rude awakenings.

The result of this was that an unusually keen interest was taken in all that pertained to earthquakes, and the new-comers, one and all—by speech, writing, or by special investigation—contributed to the advancement of seismological knowledge.

Amongst the many workers stationed in Tokio we find the names of Verbeek, Wagener, Knipping, Chaplin, Mendenhall, Ewing, Gray, Perry, Ayrton, West, Alexander and Knott; whilst amongst the Japanese, no less enthusiastic than their new colleagues, we see the names of Sekiya, Omori, Hattori, and many others. Outside assistance came from Bissett and Talbot in Yokohama, Fukushi in Sapporo, and a number of other workers throughout Japan.

At this time Tokio was in reality a city of many inventions, all of which were for the purpose of obtaining trustworthy information about earthquakes; their name was legion, and it is no exaggeration to say that of seismographs, seismoscopes and seismometers, more than one worked with at least fifty different devices.

One great problem which presented itself was to suspend a mass of material so that at the time of an earthquake it should practically remain at rest. The solution was first sought for in the bob of an ordinary pendulum. It being supposed that greater stability would be attained if the lengths of the pendulums were increased, three enthusiasts, in order to obtain a support from the roof timbers of their houses, cut holes through two ceilings, and the bobs of long pendulums were even to be seen in drawing-rooms.

Inasmuch as it was found that whenever a heavy earthquake occurred these pendulums were caused to swing in some instances so violently that apparatus in their vicinity was wrecked, attempts were made to render them dead-beat and next astatic, and a series of experiments were started which it would require pages to describe.

Following ordinary pendulums came horizontal pendulums, combinations of ordinary and inverted pendulums, rolling sphere and cylinder seismographs, ball and plate seismographs, parallel motion seismographs, and such a multitude of devices—not only for recording earthquakes, but also for timing them—that about 1883 it was decided to hold a public exhibition of earthquake apparatus. This was held in Uyeno Park; it lasted three days, and people flocked in such numbers to see the exhibits, that police assistance was called in, and the sight-seers were admitted in batches of about fifty.

Although in Japan, as a whole, there are on the average two or three earthquakes per day, whilst at many stations fifty to eighty shocks may be recorded during a year, because the disturbances came at unexpected times and from unexpected quarters, the appetite of the Tokio seismologists was so far from being satisfied that a series of experiments, which extended over several years, were inaugurated on artificially produced earthquakes.

The shakings were obtained at first by the fall, from heights up to about thirty feet, of a ball approaching a ton in weight, and subsequently by the explosion of charges of dynamite and gunpowder in boreholes.

The resulting vibrations—longitudinal, transverse, and vertical—were recorded at a series of stations so arranged in electrical connection that the time of any vibration could be noted to within a small fraction of a second.

Spare time was occupied in analysing earthquake registers and the carrying out of seismic surveys. The first of these was on an area of about nine acres, the next extended over the city of Tokio, whilst the last embraced a district some 500 miles in length, extending from the capital to the northern island.

In the first of these surveys a number of similar seismographs, one of which was in a pit, were connected together in the same manner that instruments had been connected when studying the effects of artificially produced disturbances; but with the latter, although a certain number of seismometers and seismographs were employed, the records were largely dependent upon information received on post-cards respecting the time at which a disturbance had occurred, and observations respecting its duration, direction, and severity.

This work, together with investigation on the volcanic phenomena of Japan, the more or less mysterious sea waves which occasionally inundated the coast, the supposed relationship that might exist between magnetic, electric, and seismic phenomena, the effect of earthquakes upon the lower animals, for studying which Prof. Sekiya kept a pen of pheasants, and a variety of other investigations formed interesting occupations for many.

On February 22, 1880, seismic enthusiasm was brought to a head by a very severe shaking, which gave to Yokohama the appearance of a town which had been bombarded. Taking advantage of the disturbed state of mind common not only to those who were repairing their roofs and chimneys, but to the whole community, a meeting was called, and in less than sixty minutes the Seismological Society of Japan, with its rules and regulations, was established. Many paid their subscriptions before they left the hall.

One great incentive to the work was competition between rival bodies, and many a time a member of the new Society, because his seismogram of the last quake was insignificant as compared with that obtained by a neighbour, after bitter controversy returned homewards from a meeting with a sad heart. At first these differences were regarded as the results of differences in the adjustment or construction of the instruments which had been employed, and it was not before sharp battles had been fought that it was recognised that the differences were due to differences in the localities of installation.

The feeling which at this time prevailed was not unlike that which characterises many sportsmen who, in the ordinary affairs of life, are everything that is admirable, but in the excitement of the field the desire to excel exceeds all others.

After seventeen years the seismic fever has abated, and we say with the poet—

"*Haec olim meminisse juvabit.*"

Now what was the good of all this expenditure of time and money in the endeavour to trap the fleeting earth-

quake? The earthquake-hunters of Japan, no doubt, saw a little that was before them; but now, when they stand beside the elaborate seismographs of the present day, costing 50*l*. or 100*l*., and look backward upon the days when pins were propped up in rows to act as seismoscopes, and twopence would buy a bit of string and a bob for a pendulum, I do not think that it was ever anticipated that the study of earthquakes would lead to the knowledge which we now possess.

In seismometry we have seen the gradual evolution of several types of instruments which give faithful records of the amplitude, period, duration, and the time of occurrence of all ordinary earthquakes.

For this work we are greatly indebted to Ewing and Gray, and it is fair to say that the seismometry of Japan has done much to revolutionise seismometry throughout the world. The examination of earthquake records completely changed our ideas of earthquake motion, and we learned that nearly all the formulæ which up to this time had been employed to calculate earthquake elements had been founded upon a wrong hypothesis. The fact that the period of earthquake motion increased as it died out and as it radiated, coupled with a discussion of the observations made upon the movements which had occasionally been observed in the bubbles of levels, magnetographs,

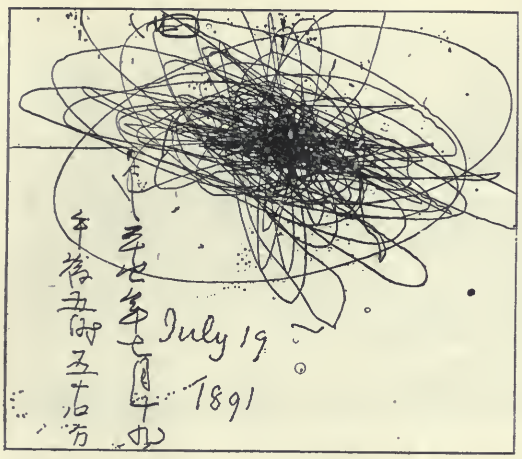


FIG. 1.—Static diagram of the earthquake of July 19, 1891, showing the complicated direction of motion common to most earthquakes. (Milne.)

and other instruments, and, above all, that now and then unfelt earthquakes had been recorded, enabled one investigator to state, fifteen years ago, that it was "not unlikely that every large earthquake might with proper instrumental appliances be recorded at any point on the land surfaces of our globe"—a prediction which of late years has been amply verified.

It was found that modified forms of seismographs might be used to record the joltings of a railway carriage, and thus to indicate defective points along a railway line. Another application of seismometry has been to measure the steadiness of a locomotive, which in part depends upon the manner in which it is balanced. On Japanese railways this has been turned to practical account, with the result that a saving of from 1 to 5 lbs. of coal per mile per locomotive has often been effected. The modern seismograph is also used to measure the elastic vibrations of bridge work, buildings, and steamships.

The greatest material benefits which recent seismological investigation has conferred upon the world are those which have resulted in minimising the destruction of life and property. The builder now, rather than making a structure strong because an earthquake is strong, has before him definite measures and a clear knowledge of the character of the forces he may expect to meet. Given the dimensions and tensile strength of a body that has been overturned or shattered, we can calculate the maximum acceleration to which the same

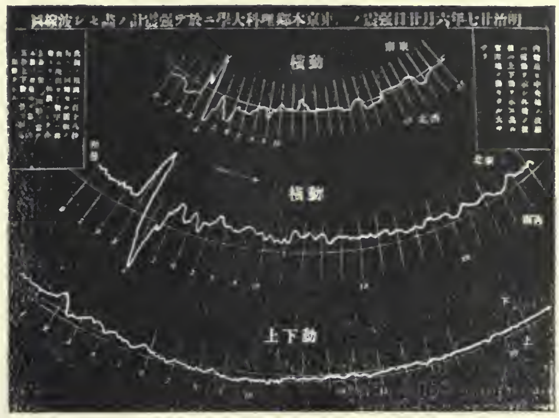


FIG. 2.—Earthquake of June 20, 1894, recorded at the Science College of the University of Japan. The upper figure is the S.E.-N.W. component; the middle, the N.E.-S.W. component showing preliminary vibrations, the shock, and concluding vibrations; and the lower, the vertical motion. The intervals are the seconds of time. (Ewing's Seismograph.)

has been subjected, and that quantity is practically identical with that derived from a seismogram.

By experience we know the maximum acceleration which may be expected in a given district or on a given

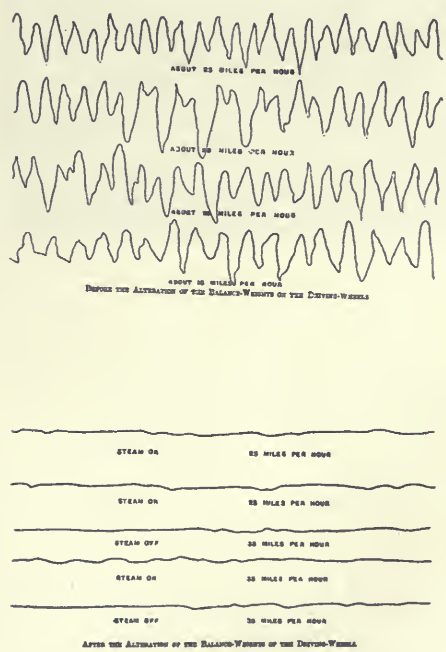


FIG. 3.—The fore and aft motion of a locomotive as balanced in England and after rebalancing in Japan, by which a safe speed has been increased from 28 to 35 miles per hour, and coal saved. (Macdonald.)

site, and we can therefore proportion a structure to meet the known conditions.

The fact that the new rules take into consideration that buildings have to withstand measurable stresses, due

to more or less horizontal displacements applied at the foundation, have been largely adopted in the building of houses and the works of engineers, is a testimony that they have been well worthy of consideration. The correctness of the new methods is found in the fact that in very many instances tall chimneys, as well as those of ordinary buildings, together with buildings themselves embodying the new principles, remain standing, whilst the old types have fallen or at least been shattered. When we remember that on June 15, 1896, Japan lost nearly 30,000 of her people by earthquakes and sea-waves, that on October 28, 1891, the loss of life was about 10,000, and the cost to restore railways and other works involved an outlay of approximately 3,000,000*l.*, that the Calcutta earthquake on June 12, 1897, is to be followed by an expenditure of 35 lahks of rupees for the restoration of public works, for the payment of which the Chief Commissioner of Assam applies for a grant from the Imperial revenue, the importance of anything which will minimise the effects of these great catastrophes can not be over-estimated.

In Japan engineers and builders are already crystallising the results of experience and experiment, and stereotyped methods of construction are being gradually

FIG. 4.—Gravestone as seismometers, indicating direction and intensity of movement. (Omori.)

abandoned, with the result that after fire, flood, or earthquake, or as other opportunities present themselves, new types of structure are growing up, which have already shown themselves to be better than the old.

Even if these results represented everything that the pioneers of the new seismology had achieved, they carry with them a feeling of satisfaction that the study of earthquakes has not been altogether unfruitful, but has led to that which is practical and simple in its application.

The experiments in which vibratory movements of the ground were produced by artificial means, whilst reproducing and affording an explanation of many phenomena observed or expected in earthquake disturbances, directed attention to others, the existence of which was for the first time rendered probable.

The velocity of propagation of wave motion evidently increased with the intensity of the initial disturbance; it was greater for vertical and normal than for transverse waves, whilst motion was propagated more rapidly to stations near an origin than between stations which were at some distance from the same.

The period of the movements increased as a disturbance died out, or as it radiated. A wave which had a slight notch upon its crest by the gradual growth of the riplet, as the motion radiated from its origin, was seen to change into a double wave. Within 50 or 100 feet of an origin, the first movement was due to a wave of compression, but beyond this distance a separation between normal and transverse movements was not observable.

The manner in which a shadow area, formed behind a cutting or hill, was invaded by movements creeping round the two ends of the obstruction was remarkable. These and many other results were confirmed and extended by actual seismograms obtained from a series of stations situated on a piece of ground less than ten acres in area. The motion on one side of this piece of ground was invariably so much greater than it was upon the other side, that it afforded an explanation of the peculiar distribution of ruin, sometimes observed in a city after a disastrous earthquake.

The fact that the side of greater motion was that, where the ground was soft, and the confirmation of this by observations in other localities, was a matter that attracted the serious attention of architects and builders. Another observation which has received many practical applications, especially in connection with the foundation of buildings, was that at a depth of 10 or 20 feet the

FIG. 5.—Destruction of an ordinary European structure (a cotton mill at Nagoya) by the earthquake of October 28, 1891. (Burton.)

movements of the ground were found to be less than they were upon the surface.

The seismic survey of North Japan, which has been extended to cover the whole empire, shows clearly that the volcanoes, extending for the most part along the backbone of the country, have no immediate connection with the earthquakes, nearly all of which originate along the eastern seaboard. Many of the largest of these have their home beneath water which in certain places exceeds a depth of 4000 fathoms, and it is in these sub-oceanic recesses at the base of a continental dome where a certain class of geological activities, which from time to time are announced to us by the shaking of the ground, are most pronounced.

The earthquakes of one region have been separated from those of another, whilst the land area which was sensibly shaken by each disturbance is well known.

The advantage of these registers when, for example, we seek for a connection between earthquakes and lunar attraction, or the rising of the tide upon a coast, because these influences attain a maximum in different localities at different hours, must be apparent.

Thanks to Dr. C. G. Knott, who first subjected earthquake statistics to rigid analysis, to Dr. C. Davison, who so ably emphasised and extended these methods of

investigation, and to Dr. F. Omori, our knowledge of annual, semi-annual, diurnal, and other earthquake periodicities has been placed on a more certain basis than it formerly occupied.

Without entering into the observations which have been made upon magnetic phenomena, sea waves, sound phenomena, the behaviour of lower animals, and a variety of other subjects connected in a greater or lesser degree with exhibitions of seismic force, what has been said indicates that the study of earth movements, which we feel, have not been without profit.

In Japan, at its University, there is a chair of Seismology; a bureau, which in 1895 controlled 968 observing stations; whilst the Government give liberal support to a committee of engineers and architects, whose duty it is to carry out investigations which may lead to the mitigation of earthquake effects.

Notwithstanding the opportunities which Japan offers to make such investigations, it is worthy of note that two trained men were ordered by the Government of that country to report upon the recent earthquake in Assam. This they have done, and no doubt Japan is now in a position to avoid forms of construction of which she was hitherto without experience. J. MILNE.

(*To be continued*).

THE AREQUIPA OBSERVATORY.

PROF. PICKERING has conceived and carried to a successful issue many projects that require both mechanical skill and confidence in his resources. In the gradual development of these schemes, we have seen the modest row of volumes, that contained the annals of the Harvard Observatory prior to his directorate, increase to imposing proportions. We know how deftly he holds the strings that control the operations of many departments outside Harvard, and how efficiently he copes with the work that a whole army of astronomers submits to his examination. But assuredly the equipment and maintenance of the observatory at Arequipa will be remembered as one of his most successful achievements. We are apt to think of a subsidiary observatory, especially when situated in a position difficult of access, as one temporarily occupied for a definite purpose, and requiring but few instruments, mounted in buildings of slight construction. But the energy of Prof. Pickering has established in South America an observatory that a State government, having the resources of a public exchequer at its will, might look upon with satisfaction. We reproduce in Fig. 1 (p. 250) the general appearance of this astronomical station, some 8000 feet above the level of the sea, and a mere glance will show or suggest how varied must be the work of the observatory, in which all the telescopes under the different sheds are kept constantly employed through every clear night. In the illustration the observer's residence is on the extreme right. Starting from that point and taking the several buildings in order as we approach the left, we have first of all a laboratory with developing rooms attached, next a shed containing a 5-inch visual telescope, which leads on to another containing a 20-inch mirror of short focal length, figured by Dr. Common for the observation of the solar eclipse of 1889. We then pass a building containing the principal clocks and a transit instrument, and come to that containing the Bache telescope of eight inches aperture. Next to this is the 13-inch Boyden telescope under a cylindrical drum roof. To the left of this, and before we come to the buildings occupied by the assistants, is a telescope with a Voigtlander portrait lens as an objective in which are taken photographs of four hours' exposure of faint nebulous regions of considerable extent. To this list of instruments must now be added the Bruce photographic telescope, having an objective doublet of 24 inches aperture, and from Prof. Pickering's last report we learn that a transit photometer similar to that in use at Harvard has been erected. Photographs of all the bright stars from the North to the South Pole are now obtained when they cross the meridian on every clear evening, either at Cambridge or Arequipa or both.

We shall get a good idea of the use to which these instruments are put if we describe some of the illustrations that Prof. Pickering has given in the volume containing the "Miscellaneous Investigations of the Henry Draper Memorial." We have first of all a picture of the Southern Cross on which abuts a portion of Herschel's Coal-sack region, taken with the Bache telescope, exposure 127 minutes, covering an area ten degrees square. We might make this plate the excuse for discussing several points of great interest. First, should photographs represent

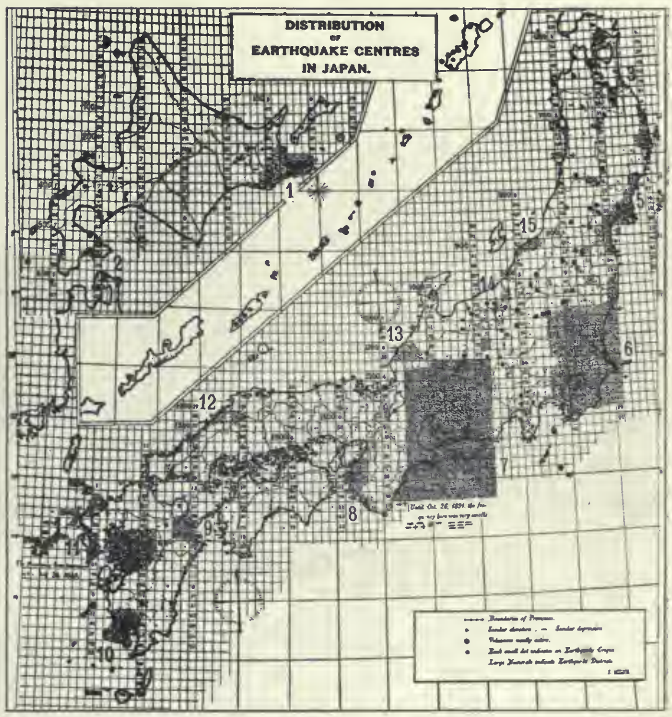


FIG. 6.—Map showing the origins of 8331 shocks recorded between 1885 and 1892 in Japan. The large dots indicate the positions of active volcanoes. The small dots indicate the origin of different earthquakes which group themselves into fifteen districts, each marked by a large numeral. (Milne.)

the stars on paper as positives or negatives? Prof. Pickering, by his practice, is clearly in favour of exhibiting the stars as black dots on a white ground. In this decision he has been guided by the use of ordinary star charts, in which there has never been any question as to the most convenient method of representing stars, and to which astronomers have already accommodated themselves. With regard to the important question of the scale to be adopted, and which in this telescope gives three minutes to the millimetre, it will be admitted that it is too small for star charts, if faint stars are to be represented. Prof. Pickering says distinctly that the images are too near together to be conveniently studied. It is mainly for this reason that we do not reproduce the plate, which would have been interesting since it affords a good illustration of the difference between photographic and visual magnitudes. γ Crucis, which has a spectrum

of the third type and is very red in colour, appears on the print much fainter than δ, while ε Crucis, also a third type spectrum star, which to the eye is so conspicuous that it is usually inserted in rough diagrams of the constellation, as for example on the Brazilian postage-stamps, is on the negative so faint, that it would not be selected as one of the principal stars.

The trifid nebula in Sagittarius, taken with the same telescope and exposure, illustrates still more completely the inadequacy of this scale for star maps, but brings out well the structure of such portions of the Milky Way as fall on the plate. This particular region is remarkable for the number of gaseous nebulæ that fall within the area covered by the plate. One-tenth of the whole number hitherto discovered in all parts of the sky are here depicted; but almost every night increases the number of these objects in our catalogues. The examination of only two plates taken with the Bruce telescope and objective prism showed that the spectra of six known nebulæ were gaseous. We pass over There seems to be no doubt about the place of the nebulæ so described, as a curved line of stars noticed by Herschel is recognisable. But of the nebula itself there is no trace. One seems to have another instance of variability similar to Hind's nebula in Taurus. The spectra of the stars contained in this portion of the sky is also illustrated. By placing a prism in front of the objective of the Bache telescope and exposing for 140 minutes, we have, exhibited on one plate, more than 1000 spectra. Where the stars are densest the separate spectra cannot be recognised in the print, but on the original negative even these can be conveniently classified. No less than fourteen stars within this limited area, out of a total of sixty-three already catalogued, show a spectrum which consists mainly of bright lines.

The cluster known as ω Centauri is admittedly the finest in the sky. We reproduce, in Fig. 2, a reduced form of the illustration of this superb object as it depicts itself in the Boyden telescope after two hours' exposure. In one particular this picture fails to do justice to the original in the sky. The photographic images have sensible diameters amounting to, perhaps, three seconds of arc. This suggests the possibility that some stars are hidden by those nearer to us, but, as Prof. Pickering remarks, in the telescope each separate star can be distinguished, and therefore it is not probable that any star is actually occulted. The only two other clusters in the sky, which though far behind, are to some extent comparable with ω Centauri in brilliancy, are 47 Tucanæ, and the well-known cluster in Hercules, Messier 13. In each of these clusters Prof. Bailey and the staff have made attempts to count the number of stars visible, and Prof. Pickering has submitted the results to a mathematical analysis. He finds that the number of stars per square minute of arc increases in arithmetical progression as the centre is approached, and that the theoretical number derived from his formula agrees fairly well with the actual count. In the case of ω Centauri the number actually counted was 6336, while

FIG. 1.—Arequipa Station from the south-west.

the photographs of the Magellanic clouds, reproduced in the volume by contact printing, and reach the nebulous region round η Argus, or as Prof. Pickering prefers to call it η Carinæ. This has been the subject of so many illustrations that its main features are well known. It serves here as an admirable object on which to test the advantages of increased scale. Three different enlargements of the original negative are given, one taken with the Boyden telescope. Prof. Pickering apparently prefers a scale of ten seconds to the millimetre at least for districts where the stars are much crowded. This size seems to him to possess the advantage of showing nearly all the stars that can be seen upon the original negative, without rendering the images inconveniently large. On a careful comparison being made between the nebulæ recorded on the plate and those given in Dreyer's catalogue one very important difference was noted. N.G.C. 3199 was observed by Herschel on four nights, and on each occasion described by him as very large and bright.

theory gives 6475. The stars in the cluster 47 Tucanæ are divided into bright and faint stars. The number of each counted is 1495 and 740 respectively, while theory gives 1495 and 734. We, in the Northern Hemisphere, think Messier 13 a magnificent object, but the number of stars counted is only 723, while theory assigns one more. It says much for the admirable character of the photographs that, notwithstanding the closeness of the stars and the consequent tendency for the individual members to be obscured by the spread of the images, it should be possible to count the stars with approximate accuracy. And further, the individual stars are so distinct that variations of brilliancy are easily recognised. In this way no less than eight new variable stars have been detected in the cluster of ω Centauri, while six have also been discovered in the south following portions of the cluster 47 Tucanæ. The occurrence of a large proportion of variable stars in star clusters is a most interesting subject of inquiry. Counts have been made of the number and distribution of stars in several clusters, with the result that 400 were found in these objects. Nearly 7000 estimates were made of the brightness of the 120 variables contained in ω Centauri, and of the eighty-five variables in Messier 5.

It might be thought from this short summary that Prof. Pickering is interesting himself mainly in these very interesting objects. It must be remembered, however, that they come naturally before him in the course of a complete survey of the whole heavens, and that while we have referred to only a few plates, the entire scheme had on January 1, 1895, resulted in the collection of no less than 12,777 plates taken by the Bache, and 6281 by the Boyden telescope. Such a mass of information is likely to yield many discoveries, some of which are given in this volume before us, but to which we cannot adequately refer. This is the case with the discussion of that interesting variable, Nova Normæ, which in nineteen days sprang from a magnitude below visibility to the seventh, and then gradually faded away, passing beyond the reach of the most powerful telescopes in about two years. Comparisons of its spectrum with that of Nova Auriga are given, showing the hydrogen lines bright in both stars, and each accompanied by dark lines of slightly shorter wavelength.

Fig. 2.—ω Centauri.

ERNEST HART.

Mr. Ernest Hart, editor of the *British Medical Journal*, died on January 7 at Brighton, where he was staying for the benefit of his health. He had suffered from diabetes for many years, and had been compelled to submit to amputation of the leg last September. The operation though successful only postponed the fatal termination of his illness.

Ernest Hart was born in London in 1836, and received his early education at the City of London School during the headmastership of Dr. Mortimer. At school he performed prodigies of prize-winning, and would have taken up a scholarship to Cambridge, in the same year as the late Sir John Seeley, but for the disabilities under which the Jews then lay at the older Universities. He resolved to enter the medical profession, and joined Lane's School, then attached to St. George's Hospital. He became a member of the Royal College of Surgeons in 1856, and after serving the office of Resident Medical Officer of St. Mary's Hospital, was appointed Ophthalmic Surgeon and Lecturer on Ophthalmology at that hospital. Subsequently he became Aural Surgeon also, and for some years held the office of Dean of the Medical School. He was already a valued member of the staff of the *Lancet*, then still directed by its founder, Mr. Thomas Wakley, M.P.; and though he engaged, not without considerable success, in the practice of surgery, and especially of ophthalmic surgery, his heart was in public work. Even as a student he had given evidence of his natural bent by organising a society, to which he acted as secretary, which had for its object to ameliorate the depressing and injurious conditions under which the Naval Medical Service then laboured. This movement was completely successful, as was also another in which he took an active part as one of a commission appointed by the *Lancet* to inquire into the nursing and other arrangements of the poor law infirmaries in London. The

Home Secretary was by the facts thus brought to light led to appoint a special committee, and, as a result of its report, Gathorne Hardy's Act was passed. This Act, by the establishment of the Metropolitan Asylums Board and in other ways, has worked an immense improvement in the care of the sick, infirm, and imbecile poor.

Ernest Hart's great opportunity came in 1866, when he was appointed editor of the *British Medical Journal*, then, as now, published by the British Medical Association. He threw his whole energies into the task of making the *Journal* more useful to practising members of the profession, while at the same time extending and consolidating its influence on the course of public health legislation and administration. A special Parliamentary Bills Committee was appointed. Of this he was elected chairman, and through it he did most of the work which earned him his reputation as a sanitary reformer. Among the subjects to which he gave special attention were the amendment of the Public Health Acts, the introduction of the system of notification of infectious diseases, and of the registration of plumbers; the improvement of factory legislation, and of local administration in public health matters, the abatement of the smoke-nuisance, and the desirability of replacing arm-to-arm vaccination by the use of calf lymph. On all these matters his industry in accumulating facts and his power of arranging them into a logical statement of the need for reform and the mode in which it should be carried out, were of great value in moulding professional and public opinion.

His chief claim to recognition as a man of science rests on his life-long study of the dissemination of certain infectious diseases by water specifically contaminated. His attention was early directed to the matter during the investigations of the curious outbreak of cholera at Theydon Bois in 1865, and of the more extensive epidemic in the East-end in 1866. Subsequently he gave much attention to the question of the dissemination of typhoid fever by the same vehicle, and gradually accumulated a mass of evidence drawn from the successive object-lessons provided by municipal authorities in various parts of the country, which put beyond question the fact that, whatever may be the cause of the endemicity of typhoid fever, the specific contamination of drinking water is the immediate cause of epidemics of that disease. In 1894, during a tour in India, he expounded this doctrine and its application to the conditions of Eastern life. The greater degree of importance which the Government of India is now disposed to attach to bacteriological investigations is to be attributed in no small degree to Mr. Ernest Hart's forcible advocacy.

His chief recreation in his later years was the study of Japanese art. He formed a large and choice collection. A few years ago he visited Japan, in the company of his wife, who was also his companion during his journeyings in India and Burmah, and lives to mourn his loss.

He was a man of great alertness of mind, of untiring industry, of steady perseverance, and strong convictions. These sometimes brought him into controversies in which he showed himself a hard hitter; but he was always ready to sink personal differences for the public good.

NOTES.

A CABLEGRAM received from Ratnagiri on Saturday last, informs us that H.M.S. *Melpomene*, having on board Sir Norman Lockyer, K.C.B., F.R.S., and other members of his eclipse party, has arrived at Viziadurg. Following the scheme drawn up last year at Norway, Sir Norman Lockyer hopes to take advantage of the keen sight and trained faculties of the officers and men of the ship's company to obtain observations during the forthcoming eclipse. He has asked for volunteers, and has obtained as many as 115. Unless unforeseen circumstances arise, the records obtained by this large number of observers will assist in making the eclipse memorable in the annals of astronomy.

WE regret that by an oversight the name of a distinguished Fellow of the Royal Society was not mentioned in our note on the New Year Honours. We refer to Brigade-Surgeon Lieut.-Colonel Dr. George King, who has been promoted to be a Knight Commander of the most eminent Order of the Indian Empire (K.C.I.E.). Sir George King is renowned as an Indian botanist, and for the valuable services he has rendered in connection with the introduction and cultivation of the cinchona in India. He is Superintendent of the Royal Botanical Gardens, Calcutta, and also of the Government Cinchona Plantations, Darjeeling.

AMONG the new officers of the Legion of Honour we notice the names of M. Henri de Parville, editor of *La Nature*; Dr. G. Hayem, professor in the Faculty of Medicine of the University of Paris; Dr. Raymond, professor in the same Faculty; M. Paul Buquet, director of the Central School of Arts and Manufactures; and M. Jourdan, director of the School of Higher Commercial Studies. Among the new Chevaliers of the Legion of Honour are: M. Albert Gauthier-Villars; Prof. Grouvelle, professor of industrial physics at the Central School of Arts and Manufactures; M. Leclanché, maker of electric batteries; M. Auguste Lumière, manufacturer of photographic plates; and M. Molteni, manufacturer of projection apparatus.

AT a meeting of the managers of the Royal Institution, held on January 6, Prof. E. Ray Lankester, F.R.S., was elected Fullerian Professor of Physiology in the Royal Institution.

M. VAN TIEGHEM has been elected Vice-President of the Paris Academy of Sciences for the current year, in succession to M. Wolf, who passes to the presidential fauteuil.

THE Watt Memorial Lecture, given at Greenock on the anniversary of the great engineer's birth, will this year be delivered by Prof. Thorpe. The subject will be "James Watt and the Discovery of the Composition of Water."

THE Geological Society of London will this year award its medals and funds as follows:—The Wollaston medal to Prof. F. Zirkel; the Murchison medal and part of the fund to Mr. T. F. Jamieson; the Lyell medal and part of the fund to Dr. W. Waagen; the balance of the Wollaston fund to Mr. E. J. Garwood; the balance of the Murchison fund to Miss J. Donald; the balance of the Lyell fund to Mr. Henry Woods and Mr. W. H. Shrubsole; a part of the balance of the Barlow-Jameson fund to Mr. E. Greenly.

M. LE CHATELIER has been nominated, by the Minister of Public Instruction, to the chair of Inorganic Chemistry in the College of France.

SUBSCRIPTIONS are invited for the erection of a bronze monument in honour of the eminent German chemist, August Kekulé, who established stereo-chemistry. The scheme is receiving generous support, and there is every reason for believing that a memorial worthy of Kekulé's great reputation will be erected. Friends, admirers, and old pupils who wish to assist in this object are requested to send their contributions to Dr. J. F. Holtz, Berlin N. Müllerstrasse 170-171, or to Consul J. Zuntz, Bonn Poppelsdorfer, Allee 63.

IT is announced that the German Association of Naturalists and Medical Men will hold its annual meeting this year at Leipzig, under the presidency of Prof. Waldeyer, of Berlin.

PROF. P. FRANCOTTE, assistant professor of embryology in the Université libre de Bruxelles, has been elected corresponding member of the Royal Academy of Belgium.

A PROMISING career has been cut short by the death of Dr. Hugh Calderwood, demonstrator of anatomy in the University of Glasgow.

WE notice with regret the announcement of the death of Herr Dr. Freiherr R. v. Erlanger, assistant professor of zoology at Heidelberg.

AT the Passmore Edwards Settlement, Tavistock Place, on Monday evening, January 17, Sir George Baden-Powell will lecture on the discoveries made by his expedition to Novaya Zemlya in 1896 to observe the total eclipse of the sun. He will also indicate the main points that are to be observed in India at the total eclipse of the sun on January 22.

THE death is announced of Sir Charles Hutton Gregory, K.C.M.G. He was the son of the late Dr. Olinthus Gilbert Gregory, professor of mathematics at the Royal Military Academy, Woolwich, and was born in 1817. He was a consulting engineer to the Governments of several Colonies, and a past president of the Institution of Civil Engineers.

WE are glad to learn that the new Psychological Laboratory at University College, the opening of which has been unavoidably delayed, gets to work this term. Any students who think of joining the classes should communicate at once with Dr. W. H. R. Rivers, who has charge of the laboratory during this term.

BY the death of Mr. H. Stacy Marks, R.A., the world has not only lost an eminent artist, but also an enthusiastic observer of living nature. Mr. Marks was an ornithologist who gained his knowledge of bird-life by the contemplation of his feathered friends in their natural haunts. Communion with nature gave him an insight into organic life denied to many students of comparative anatomy, and he was able to convey the knowledge to others by means of his paintings. Our readers may remember two books—"Letters to Marco" and "Riverside Letters"—consisting of collections of letters on natural history topics, sent by Mr. George Leslie, R.A., to his late friend Mr. Marks. These letters have found many sympathetic readers among outdoor naturalists. Mr. Marks was one of those who "love nature for her own sake, untrammelled by the prepossessions that not infrequently accompany that love among the votaries of science or sport." His death will be regretted by men of science as well as by artists.

THE annual general meeting of the Royal Meteorological Society will be held on Wednesday next, January 19, at 7.45 p.m., when the report of the council will be read, the election of officers and council for the ensuing year will take place, and the president (Mr. E. Mawley) will deliver an address on "Weather Influences on Farm and Garden Crops," which will be illustrated by lantern slides.

ON Tuesday next (January 18) Prof. E. Ray Lankester, F.R.S., will begin a course of eleven lectures at the Royal Institution on "The Simplest Living Things"; on Thursday (January 20) Prof. Dewar, F.R.S., will deliver the first of a course of three lectures on "The Halogen Group of Elements"; and on Saturday (January 22) Prof. Patrick Geddes will begin a course of three lectures on "Cyprus." The Friday evening meetings of the members of the Royal Institution will be resumed on January 21, when Sir John Lubbock, Bart., M.P., will deliver a discourse on "Buds and Stipules."

DR. E. SYMES THOMPSON will lecture on "Tropical Diseases," at Gresham College, Basinghall Street, on January 18, 19, 20 and 21, at 6 p.m. The lectures are free to the public.

MR. R. H. SCOTT, F.R.S., has kindly forwarded to us a note, received at the Meteorological Office, from Mr. W. T. Balmer, on a remarkable lunar corona observed at Tenby on Friday, January 7. In addition to the ordinary yellow corona, two well-defined concentric circles showing spectrum colours were seen outside it. The phenomenon was most intense at 5.35, and faded away at 5.55; the golden corona, however, was visible until about 9 p.m. The sky was cloudless, but there was a large proportion of moisture in the air; Mr. Balmer's readings for the wet and dry bulb thermometer on the morning of Friday being $37^\circ.5$ and 39° respectively.

THE German scientific weekly, *Die Natur*, commences its forty-seventh annual volume with an article on the aims of the journal by Dr. Willi Ule, who has just assumed the editorship. Dr. Ule is well known as one of the rising geographers of Germany; he has done a good deal of practical work in physical geography and in the improvement of mathematical instruments. He desires to carry out the purpose of *Die Natur*—the diffusion of a knowledge of natural science—mainly by the direct description of natural scenes and phenomena, appealing to the educated but unscientific public. The paper under its new editor promises to become an important element in the scientific culture of the German people.

REUTER'S correspondent at Paris reports that the will of the late Dr. Thomas W. Evans leaves only an insignificant sum to the direct heirs, but that, on the other hand, a sum of nearly 20,000,000 francs is bequeathed to the deceased's native city Philadelphia, contingent on the fulfilment of certain conditions of a somewhat original character. For instance, the city of Philadelphia must construct a museum which will bear the name of the Evans Museum, and in which the medals, decorations, and other insignia of the deceased, as well as his clothes, will be carefully arranged and catalogued. The city must also erect on a public square a statue of Dr. Evans, the price of which must not be less than 1,000,000 francs nor more than 2,000,000 francs.

THE next annual meeting of the British Medical Association will be held at Edinburgh on July 26–29, under the presidency of Sir Thomas Grainger Stewart, K.C.B. An address in medicine will be delivered by Dr. T. R. Fraser, F.R.S.; one in surgery by Prof. T. Annandale; and one in psychological medicine, by Sir John Batty Tuke. The following are the sections and their presidents:—Medicine, Dr. G. W. Balfour; Surgery, Dr. John Duncan; Obstetrics and Diseases of Women, Dr. A. R. Simpson; State Medicine, Sir Henry D. Littlejohn; Psychology, Dr. T. S. Clouston; Neurology, Dr. Byrom Bramwell; Pathology, Dr. W. S. Greenfield; Pharmacology and Therapeutics, Dr. J. O. Affleck; Ophthalmology, Dr. D. Argyll Robertson; Laryngology and Otology, Dr. P. MacBride; Diseases of Children, Dr. Joseph Bell; Dermatology, Dr. W. A. Jamieson; Medicine in relation to Life Insurance, Dr. C. Muirhead; Tropical Diseases, Dr. P. Manson; Anatomy, Sir John Struthers; Physiology, Dr. W. Rutherford, F.R.S.

THE ninth International Congress of Hygiene and Demography will (says the *British Medical Journal*) be held at Madrid on April 10 to April 17. The Congress is under the patronage of His Majesty Alfonso XIII. and Her Majesty the Queen Regent, and the Spanish Minister of the Interior, Señor Sagasta, is President of the Organising Committee. The Secretary-General of the Congress is Dr. Amalio Gimeno y Cabañas, Professor of Hygiene in the University of Madrid.

The President of the Executive Committee is Prof. Julian Calleja, the Vice-President the Marquis del Busto, Professor in the Madrid Faculty of Medicine. As far as relates to hygiene, the work of the Congress will be divided among ten Sections as follows: microbiology in relation to hygiene; prophylaxis and transmissible disease; medical climatology and topography; urban hygiene; hygiene of alimentation; hygiene of infancy and of schools; hygiene of exercise and labour; military and naval hygiene; veterinary hygiene, civil and military; sanitary architecture and engineering. The part of the work relating to Demography will be divided among three sections as follows: technics of demographic statistics; statistical results in relation to demography; dynamical demography (movements of population, &c.). A British Committee, of which Sir Douglas Galton, K.C.B., is Chairman, has been formed to secure the co-operation of sanitarians in this country, and generally to promote the success of the Congress. Programmes of the subjects to be dealt with, and all other particulars, may be obtained from the Honorary Secretary to the British Committee, Dr. Paul F. Moline, 42 Walton Street, Chelsea.

A CABLEGRAM through Reuter's agency, dated January 6 at Bombay, states that plague returns for Bombay show 142 cases and 105 deaths during the preceding forty-eight hours. Later news states that on January 8-9 there were 159 cases and 126 deaths. The total mortality during the present outbreak is 406. The epidemic is now following closely the lines of the original outbreak, and ominous rumours are circulating to the effect that unless things improve by the time of the forthcoming solar eclipse, there will be a serious exodus and a general suspension of business.

THE memorial presented to the Department of Woods and Forests by the Guildford Natural History Society, asking that Wolmer Forest be reserved as a sanctuary for wild birds and other animals, has been passed on to the War Department, to which the forest, including the rights of shooting and sporting, is in lease. In doing so, Mr. Howard, Commissioner of Woods and Forests, takes the occasion to remark that he is disposed to think that the best mode of arriving at the objects which the petitioners have in view is to take advantage of the game laws and the present system of game preservation in order to protect animal life generally. He thinks that where game preservation is carried out only those creatures which are specially destructive of birds are kept down, and animal life generally flourishes better than it would be likely to do in other circumstances.

DR. E. ZINTGRAFF, whose death we have already announced, was one of the most energetic of the German pioneers to whom fell the work of exploring the interior of the Cameroons, after that territory had, in 1884, become a dependency of the German Empire. Born at Dusseldorf in 1858, Dr. Zintgraff obtained his doctor's degree at the University of Heidelberg, and gained his first experience of African exploration as member of Dr. Chavanne's expedition to the Congo (1884). A year or two later he proceeded to the Cameroons, at that time a veritable *terra incognita* in respect of all but its coast line. For the space of six years his activity was unabated, and to him belongs the honour of being the first to push his way through the belt of dense forest lying behind the Coast Settlements to the open grassy plains which occupy the interior plateau, and to reach by this route the populous regions of Adamaua in the Southern Sudan, with their enterprising population of Hausas. This successful journey to the north was not made until 1889, the previous years having been occupied by detailed explorations north of the Cameroons Mountain, and by the establishment of the Barombi Station as a base from which the ultimate advance could be made. Dr. Zintgraff subsequently did much to encourage agricultural enterprise in the Cameroons. His arduous journeys had undermined his health, and the latter years of his life were spent at Teneriffe, where he died on December 5, 1897.

THE work which the late Mr. Gardiner G. Hubbard did for the cause of science is made the subject for appreciative comment in *Science*. In 1883 Mr. Hubbard and Mr. Alexander Graham Bell founded the old series of *Science*, the first editor of which was Mr. S. H. Scudder. He was what the French language terms an *entrepreneur* of scientific ideas, inventions and discoveries—the man of affairs who pushed them into the service of mankind. He was the *entrepreneur* of oral speech for the deaf, and also of the telephone, for it was through his energy and business ability that the instrument was introduced to the world and made a practical agency of intercommunication. Having accomplished this he retired to Washington, and when the National Geographic Society was founded there, he was elected first president. The function of the National Geographic Society is the discussion of the principles of geography and the diffusion of geographical knowledge among the people. To carry out this purpose Mr. Hubbard organised the *National Geographic Magazine*. Then he organised a system of bulletins designed to discuss the elements of physiography as a compendious library for teachers in the public schools, and finally he organised in the city of Washington a system of public lectures on geography, enlisting not only the members of the Society, but many other able public men in this enterprise. In all of these agencies the working geographers of Washington most heartily co-operated, and the National Geographic Society has within very few years attained remarkable influence and efficiency.

THE January number of the *National Review* has an admirable article by Mr. Gerald Arbuthnot, entitled "In Defence of the Muzzle." The temperate spirit in which it is written, and the conscientious manner in which the statistics referred to have been collected, ought to materially strengthen the hands of those who are upholding the muzzling order for dogs, in the face of the selfish and short-sighted opposition which it is receiving from a certain section of the public. In the same magazine we note also a paper by Mr. Arthur Shadwell, dealing with the recent outbreaks of typhoid fever. The writer permits himself to affirm that the medium by which the poison of typhoid fever is diffused "can hardly be anything else but water, acting directly or indirectly." The diffusion of typhoid fever is far too complicated a problem, and involves too many factors to enable water to become thus *wholly* responsible, as the writer seems to consider. Whilst contaminated water is undoubtedly an important—a very important—factor in the dissemination of this disease, there are other conditions which must be considered in this connection, and amongst such sewer-gas would seem to deserve a prominent place. Several years ago now, it was shown by an Italian investigator that the inhalation of sewer-gas markedly increased the predisposition of the subject under experiment, to suffer from the effects of typhoid poison.

IN the early days of railway engineering, little circumspection was used in laying down lines, and many tunnels were constructed which would nowadays be avoided by following the policy of evading obstacles wherever possible. An unnecessary tunnel of this kind, built fifty years ago by the North British Railway Company, and running for 3000 yards at a depth of 60 feet below the streets of Edinburgh, was afterwards discarded, another line having been constructed which carries the traffic outside the city. For a time the old tunnel remained unused, but ten years ago it was taken over by Messrs. R. and J. Paton, of Glasgow, and has since been used by them for the purpose of cultivating mushrooms. The story of this industry is briefly

told in the January number of *Pearson's Magazine*. A little consideration will show that the tunnel offers ideal conditions for the growth of mushrooms; the temperature varying but very slightly, and light being absent. The result of this combination of favourable conditions is that the Scottish Mushroom Company now practically control the market in cultivated mushrooms. The Company has eight hundred mushroom beds in the tunnel, each about 12 feet by 3 feet in size. When in full operation about one thousand bushels of spawn are used yearly. The highest output reaches five thousand pounds of mushrooms per month. The steady and constant supply has killed foreign competition in mushrooms; for it appears that, whereas ten years ago the quantity of French mushrooms consumed in Great Britain largely exceeded those of home growth, they form at present only about one-hundredth part of the total supply.

A NUMBER of remarkable instances of hallucinations connected with hemianopia, or complete blindness in one or other half of the visual field, are described by Dr. W. Harris in the course of an article in the new number of *Brain*. In one case of partial hemianopia the patient had visual hallucinations, lasting a few minutes, of folk and horses moving in a reddish atmosphere, the visions being limited to the blind field of vision. Another saw continually in his blind field a man standing at the back of his head, holding two lighted candles. A man who developed right hemianopia was troubled ten days later with hallucinations of men, flies, insects, &c. At first he recognised their unreality, but after a few days he became convinced they were real. The spectres became more frequent, and he would then hunt for them in cupboards and corners. Another case of hemianopia with hallucinations in the blind field, is that of a man who suddenly lost power of speech, using wrong words, and forgetting the names of things. During a subsequent attack of temporary loss of speech he suddenly noticed while reading that his sight was confused, and that the print seemed to run together. After that he noticed he could not see so well to the right, and he used to bump up against things on his right side, and had to be careful whilst crossing the road. He also has had visual hallucinations of animals and faces moving about to his right. Dr. Harris discusses the seat of production of visual hallucinations of this kind, and concludes that they cannot be elaborated in the half-vision centre in the cuneus of the brain, but in a higher visual centre—possibly the angular gyrus.

PROF. PLATEAU'S experiments on the conditions which induce insects to visit flowers have been referred to on several occasions (see p. 179). It is worth while, however, bringing the facts together. In the concluding part of his series of papers, "Comment les fleurs attirent les insectes," in the *Bull. de l'Acad. des Sciences de Belgique*, Prof. Plateau thus sums up the results at which he has arrived. In seeking for pollen or nectar, insects are guided only to a subsidiary extent by the sense of sight. They continue to visit scented flowers after the coloured parts have been almost entirely removed. When flowers of the same species vary in colour, they exhibit neither preference nor antipathy for one colour over another. Inconspicuous flowers hidden among foliage attract large numbers of insects. Artificial flowers made of paper or calico, even when brightly coloured and closely resembling real flowers, are not visited by insects; but they are when made of green leaves which have a vegetable scent. If flowers which have little or no nectar, and which are therefore habitually neglected by insects, are smeared with honey, insects are attracted in large numbers. On the other hand, if the nectary is removed from flowers habitually visited, their visits cease at once. The author has paid especial attention to entomophilous flowers, and finds that their exemption from the visits of insects is due mainly to their not providing them with honey. From all these facts M. Plateau draws the conclusion that the guiding sense to insects in visiting flowers must be chiefly the sense of smell.

WRITING in the *Revue générale des Sciences* for December 30, 1897, Dr. Louis Olivier describes the latest combination of the principles of the microphone and phonograph under the name of *microphonograph*, the invention of M. F. Dussaud, of Geneva, and which has been subsequently developed by M. George F. Jaubert and M. Berthon. A demonstration of the properties of this apparatus was given a short time ago at the house of M. and Mme. Eugène Pereire. From certain physiological facts, Dr. Laborde showed the possibility of rendering sounds audible to deaf mutes by this instrument, and his view received practical confirmation at the hands of Dr. Gellé, who experimented with signal success on a number of subjects to whom a sensation of sound was thus conveyed for the first time. It is suggested that the micro-phonograph may become an important factor in the education of deaf and dumb subjects. It will be remembered that a method of giving deaf mutes the feeling, or at all events the rhythm of music, was devised by Prof. McKendrick, and has been described in these columns (vol. lvi. p. 212). Finally, M. Berthon and M. Jaubert have employed the new apparatus in connection with the telephone and the kinematograph, the latter combination rendering it possible to reproduce scenes with all the attendant sounds of conversation and so forth. With this apparatus it is proposed to arrange life-like reproductions of a number of naval scenes at the Exhibition of 1900, under the auspices of the Compagnie générale Transatlantique.

WHERE certain salts, such as bromide of potassium and chloride of sodium, undergo changes of colour under the action of kathodic rays, after the method of Goldstein, it has been found by Profs. Elster and Geitel that they are at the same time rendered photo-electrically sensitive, inasmuch as in sunlight or broad daylight they lose any negative electric charges imparted to them more rapidly than in the dark. The same physicists, writing in *Wiedemann's Annalen* (62), now examine whether the same property is conferred on these salts when the coloration is produced by heating them in the presence of potassium or sodium vapour, after the manner described by Kreutz and Giesel. In the case of common salt, the electrometer readings representing the loss of charge in one minute in light were as follows:—For salt coloured by kathodic rays and kept in darkness a year, 214; rock-salt coloured brown to blue by potassium vapour, 73; natural violet salt, 23; chloride of sodium coloured by Berlin blue, + 1; the corresponding data in the dark being 0, – 10, – 2, – 3. With potassium bromide, nearly blackened by potassium vapour, in light, 171; the same bright blue, 101; the same coloured by Berlin blue, + 1; the results in darkness being – 4, + 2, 0 –. There is thus no doubt that the same photo-electric properties are conferred on the salts by potassium vapour as by kathodic rays; and, moreover, these properties exist more or less in the natural violet and blue varieties of such minerals as rock-salt and fluor-spar.

A DETAILED account of experiments in gliding flight is contributed by Mr. Octave Chanute to the *Journal of the Western Society of Engineers* (U.S.A.) for 1897. After trying many different types of gliding machines, some with as many as six superposed pairs of wings, Mr. Chanute seems to have chosen for his later experiments a form of apparatus with two narrow superposed aëro-curves of rectangular form. The most noteworthy feature of Mr. Chanute's investigations is his invention of a regulating mechanism by which the fore and aft equilibrium and stability is automatically maintained without any exertion or special agility on the part of the operator, and even the

action of side gusts of wind is considerably diminished. We observe that the wing surfaces are fixed above the operator's head, an arrangement quite the reverse of that adopted by Mr. Pilcher. Nevertheless both Mr. Chanute and Mr. Herring have made numerous glides with perfect safety, and the latter has achieved considerable success in "quartering," *i.e.* advancing at an angle with the wind along the side of a hill up which a current of wind is blowing. By this means Mr. Herring has succeeded in making a glide of 927 feet, the time occupied being about forty-eight seconds.

THE *Bulletin* of the Italian Geographical Society publishes a note announcing the successful starting from Tabriz of a small scientific expedition to Lake Urmia, under the direction of Prof. Paladini of Milan. It is intended to make a survey of the lake and the region immediately surrounding it.

APPLYING the principles laid down by Penck, in his "Morphologie," to the excellent and abundant data published by Forel, Dr. Wilhelm Halbfass has worked out in detail the morphometry of the Lake of Geneva: the results are to be found in the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* (vol. xxxii. No. 4).

THE greater part of Nos. 9 and 10 of the present volume of the *Mittheilungen* of the Vienna Geographical Society is devoted to a learned paper, by Herr Fritz Pichler, on the Noreia of Polybius and of Castorius. Herr Pichler concludes that the town called Noreia by Castorius, near Neumarkt in Upper Styria, is an unimportant station, of which there is no trace previous to 365 A.D. The real Noreia of Polybius is the same as Virunum, near Klagenfurt, Noreia being the older name, traceable from B.C. 113 for centuries backwards.

MESSRS. SWAN SONNENSCHEIN AND CO. announce that they will shortly publish a work, entitled "The Wonderful Century: its Successes and its Failures," by Dr. Alfred R. Wallace, F.R.S. The object of the volume is to give a short descriptive sketch of all the more important mechanical inventions and scientific discoveries which are distinctive of the nineteenth century, and especially to enable those, who have lived only in the latter half of it, to realise its full significance in the history of human progress. The author maintains that our century is altogether unique; that it differs from the eighteenth or seventeenth centuries, not merely as those differed from the centuries which immediately preceded them, but that it has initiated a new era, and that it may be more properly compared with the whole preceding historical period.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Miss Vine; an Egyptian Jerboa (*Dipus ægyptius*) from North Africa, presented by Mr. H. W. Wibrow; an Indian Python (*Python molurus*) from India, presented by Mr. F. J. Allpress; three Common Squirrels (*Sciurus vulgaris*), British; two Blue-faced Honey-eaters (*Entomyza cyanotis*) from Australia, a Razorbill (*Alca torda*), two Common Widgeon (*Mareca penelope*), twelve Common Teal (*Querquedula crecca*), European, purchased.

OUR ASTRONOMICAL COLUMN.

COMPANIONS TO VEGA.—One of the proofs given as to the light-gathering power of the new Yerkes telescope is that Prof. Barnard has observed a new companion to Vega, which even the Lick telescope had failed to make visible. Measures made with a temporary micrometer gave its position angle 312° and distance 53″ with respect to Vega. It is said to be much fainter than the small star discovered by Winnecke at Pulkova in 1864, whose magnitude is 14·5. In the *Astr. Journ.* (No. 414) Prof. Barnard points out that the latter companion, with position angle 288°·9 and distance 53″, is the same as that discovered by Mr. George Anderson, of the United States Naval Observatory, in 1881, but with a slightly modified position.

HARVARD COLLEGE REPORT.—In the fifty-second "Annual Report of the Astronomical Observatory of Harvard College," Prof. Pickering gives an interesting account of the work done. As regards buildings his report is similar to that from many other observatories, in that they are old and far behind observatories not only of the first rank, but even of the second class. On the other hand, however, very few can say with him "that their strongest feature is the large endowment for current expenses, which enables the large staff of forty assistants to be employed." The excellent work done at Arequipa is described in another part of NATURE (p. 249), so we will content ourselves with a brief summary of the work done in other sections of the observatory.

As before, Mr. O. C. Wendell has been engaged in the observations of variable stars, and the number of measures made is almost astounding, *e.g.* 1031 comparisons of *o* Ceti, 3296 of U Cephei, &c. Another series of interesting photometric comparisons are those made by Mr. E. R. Cram, on β Lyræ, the total number of measures being 2304

With the "Meridian Photometer" the total number of photometric settings has surpassed all previous records, numbering 100,052, and observations of all the stars of magnitude 7·5 and brighter, and north of −40°, are now nearly completed. Besides star work, measures were made of Uranus, Neptune, and nearly 500 each of Ceres, Juno, and Vesta.

The work in connection with the Draper Memorial has also been remarkable, and the hydrogen lines have been shown to be bright in the spectra of many known variables, U Cassiopeiæ, R Piscium, R Canis Minoris, and many others; also new variable stars have been detected by means of bright hydrogen lines in their spectra. The Report shows that excellent results have been attained; and such, we know, is the case from notes of discoveries made at the observatory, announcements of which have appeared from time to time in these columns.

ARTHUR KAMMERMANN.—We regret to record the death of Arthur Kammermann, astronomer at the Geneva Observatory (*Astr. Nach.*, No. 3469).

Born at Bienne in 1861, he received his higher education at the Zürich Polytechnic, leaving there in 1881 with the diploma of "Fachlehrer." At Zürich he was initiated into astronomical work by M. R. Wolf, who strongly recommended him to Plantamour, at Geneva Observatory, where he became attached as assistant.

After the retirement of Dr. W. Meyer in 1883, he had the Plantamour equatorial under his charge, and undertook astronomical photography with it; with this instrument he worked until his death, and many of his observations have been published in the *Astr. Nach.* He was largely occupied with meteorological matters; and in the chronometric work of the observatory he rendered great services which benefited the watchmaking industry, so important to Geneva.

MINOR PLANETS IN 1897.—The total number of minor planets discovered in 1897 was only eight, which is considerably below the average of recent years; so that perhaps in time we shall be able to obtain a complete list of them. The latest discoveries were those of Charlois at Nice: DL on November 23, DM, DN, DO on December 18.

WE have received from Mr. Arthur Mee a copy of his "Amateur Observer's Card Almanac." The calendar brings together in a handy form the principal phenomena for each day in the year, and it will be found useful to hang upon the walls of the observatory for reference.

PROF. G. M. SEARLE, professor of mathematics and astronomy in the Catholic University of America, has been appointed by the Pope to succeed the late Father Denza as director of the Vatican Observatory.

Science states that money has been granted by the Trustees of Amherst College for the purchase of a new telescope to replace the old instrument in use at present, and the bequest of 18,000 dollars for the purchase of a site for a new observatory will be expended as soon as the various plans for a new position have been carefully considered.

EARLY MAN IN SCOTLAND.[1]

II.

ONE may now inquire into the reason why cinerary urns, with their contained ashes, and short cists, enclosing bodies which had been buried in a bent or stooping attitude, should be associated with the men of the Bronze Age. The first and most important is the presence of objects made of bronze. In the 144 localities under analysis in which interments ascribed to the Bronze Age have been examined, bronze articles were found in thirty-four directly associated with the interments. In four of these the bronze was along with objects made of gold. In seven other interments of the same character gold ornaments without bronze were present. The men of this period were, therefore, workers in gold also; and as it has been, and indeed still can be, mined in Scotland, it is not unlikely that the ornaments had been wrought from native metal. Additional proof that the burials in short cists, and after cremation in cinerary urns, both belonged to the same period, and were practised by the same people, is furnished by the presence of articles of bronze and gold in both groups of interment.

But, in addition to metallic objects, the graves sometimes contained other implements and ornaments. In many localities articles made of flint, stone, or bone, and jet beads were associated with bronze. In others flints in the form of chips, knives, arrow-heads, and spear-heads; stone implements in the form of whetstones and hammers; bone and jet ornaments and bone pins have been found in short cists, and some of these articles also in cremation interments, unaccompanied by bronze.

Attention has been called by Dr. Joseph Anderson to the character of the bronze objects usually associated with these burials ("Scotland in Pagan Times"). For the most part they have been thin blades, leaf-like or triangular in form, and either with or without a tang for the attachment of a handle. From their shape they might have been used as spear-heads, daggers, or knives. Not unfrequently the surfaces of the blade were ornamented with a punctated or incised pattern. Sometimes bronze pins, rings and bracelets have been obtained from these interments. It should, however, be stated that the bronze articles and ornaments of gold found in association with the burials are of a more simple character, and present less variety in form, purpose and decoration than those which have been got in hoards, in various parts of Scotland. It would seem, therefore, as if the people of this period, even if they were in possession of such finished and beautifully decorated swords, bucklers, axes and bronze vessels as have been got in the hoards just referred to, did not deposit them in the graves of their deceased friends and relatives. It may be, however, that the simpler articles found in the interments represent a period in the Bronze Age earlier than that in which the art of making the more elaborate articles had been acquired, when perhaps the custom of depositing grave goods had been more or less departed from.

Cinerary urns are not the only utensils formed of baked clay to which the term urn has been applied, and archæologists recognise by the names of "incense cups," "food vessels" and "drinking cups," three other varieties.

The examples of so-called Incense cups are not numerous in Scotland; they were associated with cremation interments, and have usually been contained in cinerary urns; they are the smallest of all the varieties of urn, and are, as a rule, from 2 to 3 inches high and about 3 inches wide. In one specimen from Genoch, Ayrshire, the cup possessed a movable lid. Not unfrequently the outer surface was patterned with horizontal, vertical, and zig-zag arrangements of lines. In a few cases the sides were perforated, as if to allow the escape of fumes; and it is probably from this character, as well as from their small size, which fitted them for being easily carried in the hand, that they have been termed incense cups. The burning of incense would, however, imply, on the part of the people of the Bronze Age, the possession of fragrant gums and resins such as are not indigenous to Britain, and which the ancient Caledonians were not at all likely to be in a position to procure. In most instances the contents of these cups were not preserved by the finders. An example which was discovered in 1857 at Craig Dhu, North Queensferry, covered by a larger urn, and about the size of a teacup, was filled with calcined human bones; the specimen from Genoch, found a number of years ago by Dr. James Macdonald, of Ayr, contained the burned bones and ashes of a child in its fifth or sixth year. Of the conflicting theories as to the purpose to which these cups were applied, the view that, like the large urns with which they were associated, they were cinerary, and were intended for the reception of the ashes of an infant or young child, seems the most probable.

Numerous examples of the variety of urn termed "food vessel" have been found in Scotland, and "drinking cups" although not quite so numerous, are fairly represented. In the 144 localities under analysis, the bowl-shaped food urns were found in thirty-one, drinking cups in twenty-five, and in seven instances the size and form of the urn is not stated with sufficient precision. With a few exceptions, in which the character of the burial had not been fully described, the urns were contained in short cists, in which also the skeleton of an unburnt body in the bent or contracted position was lying. In several instances it is stated that the urn, either food or drinking vessel, contained black dust, or earth, or greasy matter, but burnt bones are never said to constitute their contents. Not unfrequently, although this is not an invariable rule, the urn was placed in proximity to the head and raised hands of the skeleton.

These varieties of urn are by no means invariably present in short cists. In twenty-five localities where this kind of grave was seen, there is no record of either form of urn being present. It is obvious therefore that, though associated with so many inhumation interments, they were not regarded as necessary accompaniments, and they obviously discharged in the minds of the people of the time a different function from that of cinerary urns. The term food-urns applied to the bowl-shaped variety is probably appropriate, as indicating that edible substances were placed in them, in the belief that food should be provided for the use of the corpse. It is questionable, however, if the taller variety were drinking cups, as the unglazed clay would not fit them for the retention of liquids for any length of time. The presence of food urns in cists, along with, in some instances, implements and weapons, would point to the belief, in the minds of those practising this form of interment, in a resurrection of the body, and a restoration to the wants and habits of the previous life. It may be that placing the body in the crouching position, lying on one side, was regarded as the attitude best fitted, when the proper time came, to enable it to spring into the erect position and assume an active state of existence. The practice of cremation, however, to an almost equal extent as inhumation, by people of the same period, shows that they may not all have shared in the belief in a corporeal resurrection. But it should not be forgotten that, even in many cremation interments, blades and other objects made of bronze have been found along with the burnt bones and cinerary urns, as if for use in a future life.

The association of bronze objects, both with short cists and cinerary urns, establishes these forms of interment as practised at a time when bronze was the characteristic metal used in many purposes of life. The crouching attitude of the dead body, the contracted grave, and the varieties of urns already described, are therefore to be regarded as equally characteristic of this period, even if bronze is not found in a particular instance associated with the interment, and this view is generally held by archæologists in Scotland.

In a preceding paragraph implements and weapons made of stone, flint and bone were referred to as having been sometimes associated with bronze, and also of similar objects having been found in graves, in which, though obviously of the same class and period, no article made of metal was observed. Such an association proves that there was no sharp line of demarcation between the employment of the more simple substances used by Neolithic man in the manufacture of implements and weapons, and the use of bronze for similar purposes. The two periods undoubtedly overlapped. It has been customary to regard this overlapping as if bronze-using man had continued for a period to employ the same substances in making useful articles as did his Neolithic predecessors; that time was required before the more costly bronze, imported from foreign sources, replaced the native material, and that consequently both groups of objects became associated in the same grave.

Additional light is thrown on the mixture in the same interment of objects representing different stages of culture by a collection of goods from the grave of an aboriginal Australian, buried about fifty years ago, recently brought under my notice by Dr. R. Broom. Along with the skeleton were found a clay pipe, an iron spoon, the remains of a rusted pannikin, the handle of a pocket-knife, and a large piece of flint. The handle

[1] A discourse delivered at the Royal Institution, London, by Sir William Turner, F.R.S. (Continued from page 237.)

of the knife, with its steel back, had doubtless been used along with the flint for the purpose of obtaining fire, as in Neolithic times a similar office was discharged by flint and a nodule of pyrites. These accompaniments of the Australian interments show that men in a lower grade of culture and intellectual power utilise, as opportunity offers, objects representing a much higher civilisation. It is possible, therefore, that some of the mixed interments ascribed to the Bronze Age may be the graves of Neolithic men who, in conjunction with articles of their own manufacture, had employed the material introduced by a bronze-using race, with whom they had been brought in contact, and whose usages they had more or less imitated.

That the inhabitants of prehistoric Scotland were not a homogeneous people, but exhibited different types in their physical configuration, so as to justify the conclusion that they were not all of the same race, has long been accepted by archæologists. The first observer who made a definite statement, based on anatomical data, was the late Sir Daniel Wilson, in his well-known "Prehistoric Annals of Scotland." Whilst admitting that the material at his disposal was scanty, he thought that he was justified in stating that the primitive race in Scotland possessed an elongated dolichocephalic head, which he termed boat shaped, or kumbecephalic. This race, he said, was succeeded by a people with shorter and wider skulls, which possessed brachycephalic proportions. Further, he considered that both these races preceded the intrusion of the Celtæ into Scotland. But the evidence is by no means satisfactory that the interments from which Wilson obtained the long kumbecephalic skulls were of an older date than those which yielded the brachycephalic specimens. So far, therefore, as rests upon these data, one cannot consider it as proved that a long-headed race preceded a broad-headed race in Scotland, and that both were antecedent to the Celtæ.

Evidence from other quarters must be looked for, especially from the extensive researches of Thurnam, Greenwell, Rolleston and other archæologists into prehistoric interments in England; and by the study of the material which has accumulated in Scotland since the publication of Sir Daniel Wilson's "Prehistoric Annals."

The remains of prehistoric man in England subsequent to the Palæolithic Age have for the most part been found in mounds and tumuli, some of which were very elongated in form, others more rounded, so that they have been divided into the two groups of Long and Round barrows. There is a consensus of opinion that the long barrows were constructed by a race which inhabited England prior to the construction of the round barrows. The long barrows are indeed the most ancient sepulchral monuments in South Britain; obviously they were erected before the use of bronze or other metal became known to the people. They belonged, therefore, to the Neolithic Age, as is testified by the implements and weapons found in them being formed of stone, flint, bone and horn, and by the absence of metals. They are not widely distributed in England, but are found especially in a few counties in the north, as Yorkshire and Westmorland, and in the western counties in the south. The builders of these barrows in their interments practised both inhumation and cremation, but the burnt bones were never found in urns.

The study of the human remains obtained from the English long barrows by Drs. Thurnam and Rolleston proves that the crania were distinctly dolichocephalic, and that the height was greater than the breadth. Those measured by Dr. Thurnam gave a mean length-breadth index 71·4, whilst Dr. Rolleston's series were 72·6.

The round barrows were constructed by a bronze-using people. The crania obtained in them were, as a rule, brachycephalic. Of twenty-five skulls measured by Dr. Thurnam seventeen had the length-breadth index 80 and upwards, and in six of these the index was 85 and upwards. Only four were dolichocephalic, whilst in three the index ranged from 77 to 79. In the brachycephalic skulls the height was less than the breadth.

As similar physical conditions prevailed both in England and Scotland during the Polished Stone and Bronze periods, there is a strong presumption that the two races had, in succession to each other, migrated from South to North Britain. Unfortunately very few skulls have been preserved which can with certainty be ascribed to Neolithic man in Scotland, but those that have been examined from Papa Westray, the cairn of Get and Oban, are dolichocephalic, and doubtless of the same race as the builders of the English long barrows.

Seventeen skulls from interments belonging to the Bronze period have been examined by the author. The mean length-breadth index of twelve was 81·4, and the highest index was 88·6. In each skull the height was less than the breadth. In the other five specimens the mean index was 74; the majority, therefore, were brachycephalic. In only one specimen was the jaw prognathic; the nose was almost always long and narrow; the upper border of the orbit was, as a rule, thickened, and the height of the orbit was materially less than the width. The capacity of the cranium in three men ranged from 1380 to 1555 c.c.; the mean being 1462 c.c. In stature the Bronze men were somewhat taller than Neolithic men. The thigh bones of the Bronze Age skeletons gave a mean platymeric index 75·1, materially below the average of 81 8 obtained by Dr. Hepburn from measurements of the femora of modern Scots.[1] The tibiæ of the same skeletons gave a mean platyknemic index 68·3; intermediate, therefore, between their Neolithic predecessors and the present inhabitants of Britain. Many of the tibiæ also possessed a retroverted direction of the head of the bone; but the plane of the condylar articular surfaces was not thereby affected, so that the backward direction of the head exercised no adverse influence on the assumption of the erect attitude.

Whilst in England the Bronze Age round barrows are numerous and the burials in short cists are comparatively rare, in Scotland the opposite prevails. Whilst part of Dr. Thurnam's aphorism, viz. "long barrows, long skulls," applies to both countries, the remaining part, "short barrows, short skulls," should be modified in Scotland to "short cists, short or round skulls."

The presence of dolichocephalic skulls in the interments of the Bronze Age shows that the Neolithic people had commingled with the brachycephalic race. Similarly the Bronze men, though subject to successive invasions by Romans, Angles, and Scandinavians, have persisted as a constituent element of the people of Great Britain. The author has found a strong brachycephalic admixture in the crania of modern Scots, in Fife, the Lothians, Peebles, and as far north as Shetland. In 116 specimens measured, 29, *i.e.* one-quarter, had a length-breadth index 80 and upwards, and in five of these the index was more than 85.

The question has been much discussed whether the people of the Polished Stone Age were descended from the men of the Ruder Stone Age, or were separated from them by a distinct interval of time. The latter view has been supported by Prof. Boyd Dawkins, who contends that there is a great zoological break between the fauna of the Palæolithic, Pleistocene period and that of the Neolithic Age, and that the two periods are separated from each other by a revolution in climate, geography and animal life.[2]

Undoubtedly many large characteristic mammals of the Palæolithic fauna had entirely disappeared from Britain and western Europe, but some nine or ten species, as the otter, wolf, wild cat, wild boar, stag, roe, urus and horse, were continued into the Neolithic period; at which time the dog, small ox, pig, goat, and perhaps the sheep, as is shown by their osseous remains, were also naturalised in Britain. The continuity of our island with the continent by intermediate land, which existed during Palæolithic times, also became severed, and a genial temperate climate replaced more or less arctic conditions.

Man, however, possesses a power of accommodation, and of adapting himself to changes in his environment, such as is not possessed by a mere animal. The locus of an animal is regulated by the climate and the nature of the food, so that a change of climate, which would destroy the special food on which an animal lives, would lead to the extinction of the animal in that locality. Man, on the other hand, is omnivorous, and can sustain himself alike on the flesh of seals, whales and bears in the Arctic circle, and on the fruits which ripen under a tropical sun. Man can produce fire to cook his food and to protect himself from cold, and can also manufacture clothing when necessary. Palæolithic man has left evidence that he had the capability to improve, for the cave men were undoubtedly in advance of the men who made the flint implements found in the river drifts. The capacity of the few crania of Palæolithic man which have been preserved is quite equal to, and in some cases superior to that of modern savages. So far as regards the implements which he manufactured and

[1] *Journal of Anat. and Phys.*, October 1896, vol. xxxi.
[2] "Cave Hunting, and *Journal* of Anthropological Institute," vol. xxiii., February 1894.

employed, Neolithic man showed no material advance over the Palæolithic cave dweller.

The association of the bones of domestic mammals, which were not present in Palæolithic strata, along with the remains of Neolithic man, proves that additional species had been introduced into Western Europe at a particular period, probably by another race which had migrated northward and westward; but it by no means follows that Palæolithic man had of necessity disappeared prior to this migration, and that when Neolithic man reached Western Europe he found it, as regards his own species, a desolate solitude. How then did Neolithic man with his associated animals find his way into Britain?

Was it whilst the land remained, which connected Britain with the continent in interglacial times, and along which Palæolithic man had travelled, or was it at some subsequent period after the formation of intermediate arms of the sea? If the latter, then the further question arises, How was the transit effected? Neolithic man, so far as is known, had no other means of conveyance by water than was afforded by a canoe dug out of the stem of a tree. Although such rude boats might in calm weather serve as the means of transporting a few individuals at one time across a river or narrow strait from one shore to the other, they can scarcely be regarded as fitted for an extensive migration of people; still less as a means of conveying their pigs, dogs, goats and oxen. Hence one is led to the hypothesis that, after the sea had submerged the intermediate land of interglacial times, there had been a subsequent elevation so that Britain again became a part of the continent of Europe. If one may use the expression, a "Neolithic land bridge" was produced, continental relations and climate were for a time re-established, and a free immigration of Neolithic man with his domestic animals became possible. This may have been at the period when an abundant forest growth in Scotland succeeded the elevation of what is now called the 100-foot terrace. There is no evidence of the presence of Neolithic man in Scotland until about that period. Before this island with its surrounding and protecting "silver streak" settled down to the present distribution of land and water, there are ample data, as is shown by the three sea beaches at different levels seen so distinctly on the coast of Scotland, that frequent oscillations changed the relative positions of land and sea to each other.

From the consideration of what may be called the biological data, the conclusion seems not to be justified, that because climatic changes had led to a disappearance of certain characteristic Palæolithic mammals, but by no means of all, therefore Palæolithic man had vanished along with them. When Neolithic man reached Western Europe, he in all likelihood found his Palæolithic predecessor settled there, and a greater or less degree of fusion took place between them. Hence, as the present inhabitants of Britain may claim the men both of the Neolithic and Bronze Ages as their ancestors, it is possible that as Neolithic man migrated northward into Scotland he may have carried with him a strain of Palæolithic blood. W. T.

PROGRESS OF TECHNICAL EDUCATION.

A REVIEW of the progress of technical education in the United Kingdom during the year 1896-97 is given in the tenth annual report of the National Association for the Promotion of Technical and Secondary Education. A general idea of the present position of the technical education movement may be obtained from the subjoined extracts from the report just issued.

Technical Education in England.

It is pleasing to be able to record that, in the year 1896–97, the total amount of money available under the Local Taxation (Customs and Excise) Act, 1890, and distributed to the local authorities, was larger than in any previous year, and that a further advance has been made as regards its utilisation for educational purposes.

Of the 49 County Councils in England 41 are now giving all and eight are giving part of their grants to educational purposes, while of the 61 County Borough Councils 55 are devoting all and six are devoting part of the fund in a like manner. In the county borough of Preston a noteworthy advance has been made. In this locality a new technical institute, erected by the Harris Trustees at a cost of about 20,000*l.*, has recently been opened, and the County Borough Council, by voting a sum of 500*l.* in aid of technical education in the borough, have now retired from that position of isolation which they had hitherto occupied. At the present time, therefore, all the County and County Borough Councils in England are utilising the provisions of the Technical Instruction Acts.

In considering the amount of money devoted one way and another, it may be stated that, of the total of 807,000*l.* now available in England alone, no less a sum than 740,000*l.* is being spent upon education. It is worthy of note that London's share of the fund now reaches 185,000*l.*, of which a sum of 150,000*l.* is being utilised for educational purposes, a growth of 30,000*l.* as compared with last year's vote. Therefore, looking at the position as a whole, it is clear that education continues to receive financial support of an extending character.

In last year's report particulars were given respecting local authorities contributing funds to education in the form of *rate aid*. The information then published went to show that there were at least 137 localities providing a total sum of 34,000*l.* in this manner. To these figures must now be added a further 23 authorities raising 5000*l.*, thus making an aggregate number of 160 local authorities levying rates, or voting lump sums from the rate-fund, to the extent of 39,000*l.*

The extent to which local authorities and responsible committees in England have built, or are building, or are about to build, technical schools is shown by the fact that the number of such schools thus initiated now reaches 161, of which 146 involve a capital expenditure of 1,730,000*l.* This sum is *exclusive* of about 500,000*l.* absorbed by the establishment of polytechnic institutions in London. It is worthy of notice that in Burslem, Chesterfield, Dewsbury, Keighley, Plymouth, Rochdale, Southport and Walsall the necessary funds for building purposes were provided entirely by voluntary contributions, and that in Lancaster, Northwich, St. Helens, Sandbach and Winsford sites and technical schools have been presented to the local authorities by private individuals; it may be estimated that, with the exception of Lancaster and Sandbach, concerning which complete information is not available, the financial provision which has thus been made in eleven localities represents a total of 137,000*l.* Of the aggregate number of technical schools mentioned above, 100 are already at work, 26 new schools, situate in 13 different counties, having been opened during the past year; the localities in which the largest of these new schools are to be found and the amounts spent upon the buildings are—Leicester (40,000*l.*), Preston (20,000*l.*), Darlington (16,000*l.*), Oldham and West Hartlepool (15,000*l.* each), Darwen (14,000*l.*), Swindon (13,000*l.*), and Handsworth and Northwich (10,000*l.* each). There remain, therefore, 61 technical schools which, according to the latest information, are still incomplete; but it must be understood that this number includes localities where technical schools have been transferred to the local authorities and where new schools are also being built.

In Bradford the technical college, upon which has been spent no less than 155,000*l.* (50,000*l.* for buildings and 105,000*l.* for maintenance), mainly provided by private munificence, now receives an annual grant of 2875*l.* from the Corporation; in Huddersfield, the Governing Body of the technical college have recently decided to proceed with considerable extensions to the present buildings at an expenditure, including the cost of furnishing, of 12,000*l.*; in Keighley, the mechanics' institution was founded in 1825, a new building, costing nearly 20,000*l.*, was erected by public subscription in 1870, and an additional wing was built, at an outlay of 11,000*l.*, in 1887. Hitherto there has been but one instance of a local authority divesting themselves of their powers of direct control, namely that of Burnley, where the County Borough Council, having established a technical school at a cost of 4000*l.*, transferred the management of the same to the Committee of the local mechanics' institution, the Committee receiving an annual grant of 1000*l.* from the Council.

During the year ended March 31, 1896, the expenditure, excluding capital outlay, upon agricultural education by thirty-six County Councils in England reached a total sum of 58,349*l.*

According to the latest annual report of the Board of Agriculture, the amount of money applied to this branch of technical education by the County Councils of England (including Monmouthshire, but excluding Derbyshire, the Soke of Peterborough and the Southern Division of Buckinghamshire) during the year 1896-97 was estimated to be 78,000*l.*, which sum includes capital expenditure.

Progress in Wales.

The whole of the sum of 38,000*l.* available under the Local Taxation (Customs and Excise) Act, 1890, is devoted to the purposes of intermediate and technical education, together with an estimated sum of 20,000*l.* raised by rate under the Technical Instruction Acts, 1889 and 1891. In addition to these sums, an amount of over 17,000*l.* is raised under the provisions of the Welsh Intermediate Education Act, 1889, which sum is met by a contribution from the Treasury not exceeding the amount payable out of the county rate, and based upon the efficiency of the schools aided by the local authorities. The total sum which is annually appropriated to intermediate and technical education in Wales is, therefore, about 92,000*l.*

In Cardiff, by an agreement between the Corporation and the University College of South Wales and Monmouthshire, the entire responsibility of providing technical instruction is placed upon the college, in consideration of a large annual grant, together with all fees and grants earned by, or on behalf of, the students. The work of the college in this connection comprises the maintenance of a large number of evening science and art and technical classes, a women's technical department, and a higher technical department, and the establishment of scholarships and studentships.

Expenditure on Technical Education in Scotland.

Of the total amount of 39,000*l.* distributed to local authorities under the Local Taxation (Customs and Excise) Act, 1890, an estimated sum of 28,000*l.* is devoted to technical and secondary education. This, with the addition of an amount of 60,000*l.* available under the provisions of Section 2 of the Education and Local Taxation Account (Scotland) Act, 1892, makes the total sum devoted to technical and secondary education in Scotland 88,000*l.*, excluding those sums which are applied to technical education by six School Boards out of the school fund under the Technical Schools (Scotland) Act, 1887.

The Position of Ireland.

The year 1897 has been one of disappointment to those interested in technical education in Ireland. In February a large and representative deputation, organised by the Technical Education Association for Ireland, waited upon the Lord-Lieutenant. His Excellency, who was much impressed by the influential character of the deputation, and the arguments which they advanced, announced that it was the intention of the Government to introduce a Bill in the coming session which would deal with agricultural instruction, and promised to use his influence with his colleagues to introduce a Bill dealing with technical education at the earliest possible opportunity.

This promise was fulfilled, for not only was a Bill introduced to create a Board of Agriculture and Industries for Ireland, but provision was made in the Budget for an endowment of technical education. But the hopes, which the action of the Government raised, were doomed to disappointment. The Agriculture and Industries (Ireland) Bill, being unfavourably received by the Irish Members of Parliament owing to its financial clauses, was withdrawn; an announcement was made by the First Lord of the Treasury that as an alternative policy a Local Government Bill would be introduced during the following session, and the provision made in the Budget for technical education was otherwise appropriated.

At the end of November a still larger and more representative deputation, organised by the Dublin Chamber of Commerce, and representing all the Chambers of Commerce, the principal municipalities, and the leading agricultural and industrial organisations of Ireland, waited on the Chief Secretary for Ireland and pressed upon the Government the need of establishing a Board of Agriculture and Industries during the forthcoming session. The strongest representations were made as to the urgency of the matter. But the Chief Secretary, though admitting the urgency, informed the deputation that the Government were pledged to the Local Government Bill, and that it would not be fair to buoy up those interested in the movement with the hope that there was any reasonable prospect that the Government would be able to deal with two first-class Irish measures in the one session. The encouraging feature about the situation is that public opinion is thoroughly aroused upon this question, and there is, therefore, no fear that the matter will be allowed to drop.

Early in the year the Lord-Lieutenant appointed a Commission to "inquire and report with a view to determining how far, and in what form, manual and practical instruction should be included in the educational system of primary schools under the Board of National Education in Ireland." The Commission have held sittings in the principal Irish towns, as well as in England and in Scotland, and have sent experts to report upon the position of manual and practical instruction in connection with elementary education in Germany and France. It is expected that their report will be submitted to the Lord-Lieutenant sufficiently early in the year to allow the Government to make provision in the estimates to carry out the recommendations of the Commission.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PROF. G. KRAUSE, of Halle, has been appointed ordinary professor of botany to the University of Würzburg, in the place of the late Prof. J. Sachs.

AMONG the measures to be laid before the Prussian Diet during the session opened on Tuesday is one on the vexed subject of disciplinary procedure against University Lecturers. In the Speech from the Throne this is alluded to as a "legislative regulation of the circumstances concerning the position of University lecturers."

THE Duchess of Fife opened the new Municipal Technica- School at Brighton on Saturday last. The Duke of Fife, re plying on behalf of the Duchess to a vote of thanks passed to her Royal Highness, remarked that in establishing the school Brighton had placed itself in line with all the great centres of population in the country, and showed itself alive to the great educational necessity of the day.

SPEAKING at the annual dinner of the Yorkshire College, Leeds, on Friday last, Lord Londonderry said that England was only slowly waking up to the fact that a technical, as distinguished from a commercial or literary, education was becoming more and more essential every day. A great deal had been done by the Yorkshire College, which had to deal with a county vast in its dimensions, and containing within its limits every variety of trade industries. The College had come to the assistance of all these industries. It had rendered valuable assistance to dyeing and weaving as well as to the application of art to the textile industries, and thanks to the grant by the Clothworkers' Company of 50,000*l.* for the establishment of this department, no less than 2500*l.* a year was expended to make the College the first weaving and dyeing school in the country. Many more such institutions as the Yorkshire College are needed before technical education is sufficiently provided for the needs and requirements of the country.

TEACHERS of science and science classes in higher-grade and public elementary schools, held a meeting on Friday last in the rooms of the Society of Arts. Mr. C. J. Addiscott, President of the National Union of Teachers, occupied the chair; and in his opening address he remarked that what is needed at the present time is a sound, workable system of technical instruction, based upon science and art teaching, which itself must be based upon a solid foundation of primary instruction. He discredited the idea that our primary system should be so moulded that it should lead necessarily to a secondary system, believing that the needs of the class with which they had to deal were outside what he conceived to be secondary education, and that the satisfaction of those needs would be found in the development of the primary system through the higher-grade Board school or organised science school on to the technical institute. The main factor for successful progress in this direction must be a central authority, which should be sympathetic, which should know the needs and the difficulties of each class at each stage of the journey. A number of resolutions were passed, one of them being opposed to the recent action of the Science and Art Department in giving instructions to inspectors to report any case where 25 per cent. of the first year students leave the schools at the end of the year, or more than that percentage of the second year students leave at the end of the second year, in order that the department might consider whether such schools should continue to be recognised as schools of science.

THE Association of Directors and Organising Secretaries for Technical and Secondary Education met on Friday last at the Guildhall, Westminster. Mr. C. H. Bothamley (Somerset) was

elected chairman, Mr. Hewitt (Liverpool) vice-chairman, Mr. J. H. Nicholas (Essex) secretary, and Mr. Turner (Staffordshire) treasurer. The places of the three remaining meetings for 1898 were fixed to take place at Birmingham, Sheffield, and London. In the course of an address, the chairman remarked that the Association had repeatedly expressed its acceptance of the recommendations of the Royal Commission on Secondary Education and had expressed the opinion that they formed a satisfactory basis for legislation. Latterly they had heard a great deal about the essential importance of constituting a central authority for education before anything else was done in the matter. The constitution of an efficient central authority could properly be brought about by the reörganisation of those Government departments that dealt at present with educational matters, a reorganisation along the lines of the Royal Commission's report. They found it to be inconvenient in practice in many ways to have two entirely separate departments, one of which they were brought into contact with in connection with evening continuation schools, and the other more and more frequently in dealing with secondary schools. They wanted to see these two departments merged more or less completely into one, with their functions properly defined, and capable of dealing with secondary education as a whole, as well as with the purely scientific and technical part of it. The other part of the central authority—the educational council—was a body to which the scholastic profession naturally attached great importance. The Association thought that one of the great needs of the present time was a system of schools corresponding fairly closely with the higher primary schools of France—schools which should be a real top to the elementary education. He concluded by moving—"This Association considers that legislation on the lines of the report of the Royal Commission on Secondary Education is very urgently needed at the present time." Mr. Turner seconded, and, after a short discussion, the resolution was adopted.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xx. No. 1, January.—"The motion of a solid in infinite liquid under no force," by Prof. Greenhill, examines the elliptic function expression of all the dynamical quantities involved, and explores the analytical field by working out completely the simplest pseudo-elliptical cases to serve as landmarks, utilising the analysis which the author has developed in his paper on "Pseudo-Elliptic Integrals and their dynamical applications," in the *Proceedings* of the London Mathematical Society (vol. xxv.) and carrying out his work on the lines of his papers on the "Dynamics of a Top" and on the "Associated Motion of a Top and of a Body under no Forces" in vols. xxvi. and xxvii. (*Proc. L.M.S.*). Reference is made to the sketch of the theory in Thomson and Tait's "Natural Philosophy," and to a complete solution in the case of a solid of revolution in Kirchhoff's *Vorlesungen über Math. Physik*, ix.; and to the "Motion of a Solid in a Liquid," by Dr. T. Craig.—"Surfaces of Rotation with constant measure of curvature and their representation on the Hyperbolic (Cayley's) Plane," by G. F. Metzler. Minding (Crelle, vols. 19, 20) shows that it is easy to obtain the formulæ which express the relations between the sides and angles of a triangle of which the sides are geodesic lines on a surface of rotation with constant measure of curvature. Mr. Metzler shows that the same method holds for the formula expressing the area of the triangle (*i.e.* in the ordinary spherical formulæ put $a - \sqrt{1}$ for a, the radius of the sphere).—"Sur les Méthodes, d'approximations successives dans la théorie des Equations différentielles," par E. Picard, is a note, taken by the editors of the *Journal* from M. Darboux's "Théorie des Surfaces (à la fin du tome iv.).—M. Darboux is the mathematician whose likeness accompanies this number.

Bollettino della Società Sismologica Italiana, vol. iii., 1897, Nos. 5, 6.—The microseismographs of the Institute of Physics of the Royal University of Padua, by G. Pacher. A reprint of a paper giving a full account of the Vicentini microseismographs, already noticed in Nature.—The Latian earthquake of May 8, 1897, by G. Agamennone. A note on a series of slight shocks felt in the neighbourhood of Rome.—The Royal Geodynamic Observatory of Catania, by A. Riccò.—Notices of earthquakes recorded in Italy (April 27–May 14, 1897), by G. Agamennone, the most important being the series of Latian earthquakes of May 8, and an earthquake of distant, but unknown, origin on May 1.

SOCIETIES AND ACADEMIES.

London.

Royal Society, December 9, 1897.—"On Methods of making Magnets independent of Changes of Temperature; and some Experiments upon Abnormal or Negative Temperature Coefficients in Magnets." By J. Reginald Ashworth, B.Sc.

The object of this paper was to find what kinds of iron or steel are least liable to changes of magnetic intensity of a cyclic nature under moderate fluctuations of temperature, such as take place in the atmosphere from one season to another. The subject is of importance for the sake of improving magnetic instruments, but apart from its practical consequences the investigation points to some interesting theoretic consequences.

In general the effect of alternately heating and cooling a magnet is to cause a large loss of magnetic intensity, which is only in part recovered; ultimately a cyclic state is established in which the changes may be expressed by a formula which in conformity with custom is here written $I_t' = I_t(1 - \alpha\overline{t' - t})$, I standing for the magnetic intensity, t and t' for the cold and hot temperatures.

Hitherto α, the temperature coefficient of the magnet, has been found to be positive; that is to say, the effect of a rise of temperature is to diminish, and a fall of temperature to increase the magnetic intensity. A negative coefficient must be understood, therefore, to represent a rise and fall of magnetic intensity with rise and fall of temperature, and this abnormal effect has now for the first time been observed to be general in certain cases.

In the first place the influence of chemical composition was sought in determining the behaviour of a magnet under changes of temperature, and steel alloys severally of manganese, tungsten, cobalt, and nickel were tested, as well as a series of cast irons of different blends of pig irons. The results obtained show that the influence of chemical constituents is subordinate to that of physical condition, annealing or hardening. Thus a kind of nickel steel, the same as Dr. Hopkinson found to yield such remarkable thermo-magnetic results, exhibited in the glass-hard state a small increase of magnetic intensity with increase of temperature and decrease with fall of temperature. When annealed the converse effect took place, and these effects could be changed repeatedly by changing from hard to soft and soft to hard. Again cast iron, in the condition received from the foundry, has a very large magnetic variation for a given range of temperature, but when hardened by heating and rapidly chilling the variation becomes exceedingly small, the coefficient now being about $\frac{1}{15}$th its former amount. As hardened cast-iron magnets have also a very high permanent magnetic intensity, and are very little influenced by shocks and blows, it will be seen that they have exceptionally valuable qualities.

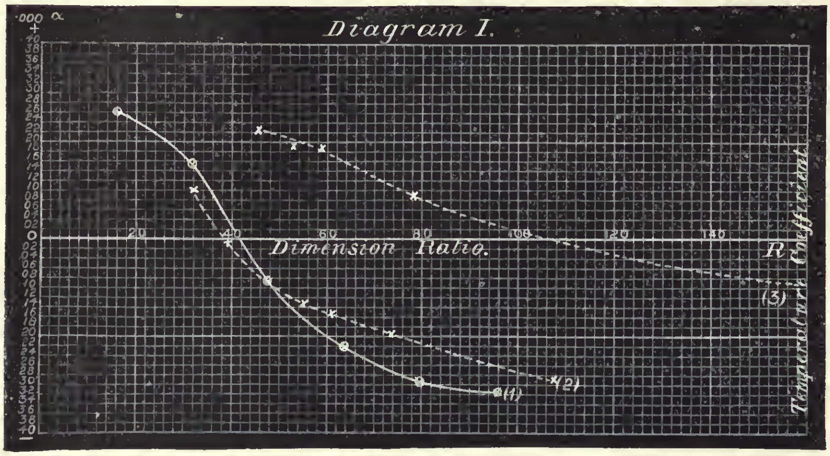
However, the most interesting results were obtained from some steel music wires which happened to be put to the test. These wires in the normal condition and when the cyclic state is established, after experiencing the usual permanent magnetic loss, exhibit a negative coefficient, the higher and lower intensities now corresponding to higher and lower temperatures, and they are thus quite exceptional. But, in contrast with the similar behaviour of the nickel steel alloys just mentioned, the negative coefficient is destroyed and a positive coefficient established if the wire be raised to a bright red heat and cooled either very slowly, as in the process for annealing, or rapidly as for hardening. If heated, however, to about a dull red and quenched, the coefficient can then be rendered just zero.

In order to gain some insight into the cause of this abnormal negative coefficient, the wire was dissolved in nitric acid and at different stages of dissolution tested. This led to the important relation, which was afterwards fully established in every possible way by a series of laborious experiments, that the longer and thinner the wire the more negative is its coefficient; and so much does the coefficient depend on the ratio of length to diameter, or dimension ratio, that by suitably altering the dimension ratio the sign of the coefficient may be changed; and for some particular dimension ratio, for a given kind of steel wire, the coefficient may be made zero, and the magnet is then independent of temperature changes.

The diagram exhibits these changes graphically. Curve (1) represents the variation of the coefficient from positive to negative for steel music wire of diameter 0·187 centimetre, and of

lengths 3, 6, 9, 12, 15 and 18 centimetres corresponding to dimension ratios 16, 32, 48, 64, 80 and 96.

Curves (2) and (3) represent similar changes in different steel wires, where the dimension ratio was varied by altering the diameter of the wire and keeping the length constant.



An almost identical curve to No. 1 is obtained by plotting against the dimension ratio the percentage permanent magnetic loss each piece suffers due to the process of alternate heatings and coolings; and as this is, without doubt, dependent on the self-demagnetising force in the magnet, it is evident the coefficient is also a function of the demagnetising force, and is principally varied by this, at least for a given range of dimension ratios.

The ultimate cause determining the abnormal negative coefficient in steel music wires of large dimension ratios is not yet completely made out, but experiments now in progress seem to indicate that it is the effect of the drawing in the process of manufacture.

"A Note on some further Determinations of the Dielectric Constants of Organic Bodies and Electrolytes at very Low Temperatures." By Prof. James Dewar, F.R.S., and Prof. J. A. Fleming, F.R.S.

December 16, 1897.—"Memoir on the Integration of Partial Differential Equations of the Second Order in Three Independent Variables, when an Intermediary Integral does not exist in general." By A. R. Forsyth, F.R.S., Sadlerian Professor in the University of Cambridge.

The memoir discusses the theory of partial differential equations of the second order in one dependent and three independent variables; and the method adopted is seen, without difficulty, to be applicable to equations which involve more than three independent variables and which can be of order higher than the second.

In order to solve a given equation, a system of subsidiary equations is constructed; and the system is made up of two parts. One of these parts is a set of simultaneous partial differential equations in two independent variables and a number of dependent variables, this number being one more than the number of the equations. An integral equivalent of this part accordingly contains an undetermined quantity. The other of the parts is a set of equations in a single independent variable; it appears that the set of equations in the second part can be consistently satisfied by a determination of the unknown quantity emerging from the first part.

The first of the three sections, into which the paper is divided, deals with the general theory, and indicates a method whereby subsidiary equations for an equation $F = 0$ of any degree in the derivatives of the second order can be constructed. If integrable combinations of the subsidiary system are not obtainable, an extension of the method shows how equations of higher order (when obtainable) can be deduced and associated with the given equation.

The second of the three sections deals with those equations of which the characteristic invariant is resolvable; and some examples are given, alike of equations for which the integration of the initial subsidiary system is possible, and of equations for which the extended method must be used.

The third of the three sections deals with those equations of which the characteristic invariant is irresolvable. Of such equations the most interesting examples are the potential equation and other equations in mathematical physics; and the theory is applied to some of these equations in detail, leading to some new solutions.

"On the Occlusion of Hydrogen and Oxygen by Palladium." By Ludwig Mond, Ph.D., F.R.S., William Ramsay, Ph.D., F.R.S., and John Shields, D Sc., Ph.D.

Palladium black prepared in the same way as platinum black contains 1·65 per cent. of oxygen, which cannot be removed *in vacuo* at a dull red heat. On heating in an atmosphere of oxygen the amount absorbed up to a red heat was about one and a half times as much as corresponds with the formula Pd_2O, and this also could not be extracted at a dull red heat *in vacuo*.

A comparative study of the occlusion of hydrogen by palladium black, sponge and foil was made; and, after taking into consideration some observations made by Graham and Dewar, it was found that no matter whether the palladium exists as black, sponge, foil, wire, or compact metal, or whether it is charged by direct exposure to hydrogen gas (the proper conditions being observed, as explained), or charged electrolytically, the amount of hydrogen occluded in each case is approximately the same, the atomic ratio palladium : hydrogen varying between 1·37 and 1·47.

The bulk of the hydrogen occluded by palladium black and sponge can be pumped off again at the ordinary temperature *in vacuo*.

The heats evolved per gram of hydrogen and oxygen occluded by palladium black are + 46·4 K (4640 *g*-cal) and + 11·2 K (1120 *g*-cal) respectively, the latter value being in harmony with the view that the absorption of oxygen is a true phenomenon of oxidation.

With respect to the supposed formation of a definite chemical compound on the occlusion of hydrogen, it is shown that Troost and Hautefeuille's deduction that Pd_2H is formed is not warranted. If any hydride is produced at all, it probably contains at least as much hydrogen as that required by the formula Pd_3H_2 first suggested by Dewar.

It is also shown that the heats of occlusion of hydrogen in platinum and palladium black are not in favour of the view which has sometimes been put forward, that the heat of occlusion of a gas represents the heat of condensation or liquefaction of the gas in the capillary pores of the absorbing substance.

Linnean Society, December 16, 1897.—Frank Crisp, Treasurer and Vice-President, in the chair.—Mr. W. Carruthers, F.R.S., exhibited and made remarks upon a fungus, *Rosseilinia ligniaria*, which had been found to attack living ash trees, eventually causing the death of the tree. Additional observations were made by Mr. George Murray and Prof. Farmer.—Mr. Edward Step exhibited two specimens of a Hermit Crab, *Eupagurus Prideauxi*, from Portscatho, Cornwall. Both were found naked and in rock-cavities, and special interest attached to the fact that, in the absence of the well-known molluscan shell which the species affects, each specimen was incrusted at precisely the same regions of its exterior by "acorn-shells."—The Rev. T. R. Stebbing gave an account of the habits of this and other species of the genus *Eupagurus*, directing special attention to the work of Aurivillius; and Prof. Howes remarked that it was on record that in the absence of a shell the bowl of a clay-pipe did not come amiss to these animals, and that they will readily utilise broken test-tubes.—Mr. H. M. Bernard read a paper on the affinities of the Madreporarian genus *Alveopora*. The question discussed was one of much interest, owing to the claim advanced by Dana, that *Alveopora* is a survival of the great Palæozoic family *Favositidæ*. This claim was rejected by

Milne-Edwards and Haime, but nevertheless was founded on close similarity of structure. Other important characters in common were now indicated, viz. the similarity of the earliest growth-stages and of the method of budding. These were described, and it was urged that there was now no reason to doubt the relationship between *Alveopora* and *Favosites* other than that which arose from the immense interval of time which had elapsed since *Favosites* flourished and from the scarcity of intermediate forms. One only had been described, viz. the genus *Koninckia* from the Cretaceous. Mr. Bernard then discussed the relationship of *Alveopora* with the recent *Poritidæ*, in which family it is usually classed. The author contended that *Alveopora* and *Poritidæ* stand about as far apart as possible in the madreporarian system, and with regard to the evolutionary stages of the madreporarian skeleton he concluded that the original columniform polyp must be considered to have had the lower portion of its body clothed with a stiff secretion which formed a cup into which the upper flexible portion could be invaginated This epithecal cup was the primitive madreporarian skeleton. Within this cup—mainly by infoldings, at first simple, but soon increasing in complexity—a new internal skeleton had been developed which had largely superseded the primitive epithecal skeleton. This internal skeleton, he thought, was as much a product of the epitheca as the apodematous systems of Arthropods are products of the chitinous cuticle. A discussion followed, in which the Chairman and others took part.—Messrs, H. and J. Groves communicated a paper on some *Characeæ* collected by Mr. T. B. Blow in the West Indies, one of which appeared to be new to science. Specimens of the plants described were exhibited.

PARIS.

Academy of Sciences, January 3.—M. A. Wolf in the chair.—M. Van Tieghem was elected Vice-President for the year 1898.—M. Chatin, the outgoing President, anncunced the changes in the Members and Correspondents during the year 1897.—General method for determining fundamental stars and latitude, by M. Lœwy. A further developement of the method announced at the previous meeting.—Histogenetic influence of an anterior form, with respect to the regeneration of Descemet's membrane, by M. L. Ranvier. It is known that the introduction of a single crystal into a solution has a considerable effect in causing crystallisation, and the present observations tend to show that an analogous phenomenon may take place in organic tissues. Observations were made upon the growth of the membrane of Descemet and its endothelium in the cornea of a rabbit, after partial destruction by incision and by a needle. In the latter case, where the corneal layers attacked by the needle have given an irregular surface, the endothelium, instead of forming a simple cellular layer, appears in the form of small masses, in which several layers of cells can be seen. The definition of endothelium thus requires considerable modification.—On the determination of the first terms of flexure of a meridian instrument. Application to the meridian circle at the Observatory of Paris, by MM. W. Ebert and J. Perchot.—On the conformable representation of one surface upon another, by M. G. Sonslow.—On the velocity of propagation of a movement in a medium at rest, by M. P. Vieille. A description of experiments upon the velocity of the wave produced by exploding varying charges of powder and fulminating mercury in a steel tube. The figures obtained show that as the initial condensations increase, the mean velocities of propagation on a length of four metres also increase from values about the velocity of sound up to four times that speed.—On a new method of interferential spectroscopy, by MM. A. Perot and Ch. Fabry. The interferential spectroscope is composed of two plates of plane glass with silvered faces opposed, the distance and orientation of which can be exactly regulated. The rings produced are observed at an infinite distance, the system being lighted by a slightly converging bundle of rays. With this apparatus M. Michelson's statement that the green ray of thallium is double has been verified.—On the mechanism of the discharge of conductors struck by the X-rays, by M. G. Sagnac. The surface of a metal, M, struck by the X-rays emits new rays termed secondary rays of the metal M. Each element of volume of gas adjacent to the metallic conductor is rendered capable of conducting electricity, both by the incident X-rays and by the secondary rays.—On a simple method for directly transforming typographical plates and other objects in feeble relief into photographs, by M. Adrien Guébhard.—On the isocyanic ethers and the heat of formation of liquid isocyanic acid, by M. Paul Lemoult. The heats of formation were determined of the isocyanates of methyl and ethyl by the method of the calorimetric bomb.—On a new cyclic ketone methylcylohexonone, by M. A. Béhal. This ketone is one of those obtained from wood oil. Oxidation with potassium permanganate gave only acetic and levulic acids. The benzoyl derivative and oxime were prepared.—Preliminary note on the origin of the subrenal capsules of lophobranchial fishes, by M. Huot. The subrenal capsules have been usually regarded as arising from the epithelium of the cœlom, but the study of the development of these organs in the embryos of *Syngnatus Dumerilii*, leads to the conclusion that they arise from two sunk diverticula each of which is a bud from the posterior portion of a Wolf's canal.—On the origin of the setigerous bulbs and the nephridia in Annelids, by M. Aug. Michel. In the caudal regeneration of the Annelids, the setigerous bulbs are ectodermic and the setigerous sacs are mesodermic; the nephridia are of a neutral origin, ectomesodermic.

AMSTERDAM.

Royal Academy of Sciences, November 27, 1897.—Prof. van de Sande Bakhuyzen in the chair.—Prof. van der Waals gave an approximate rule for the course of the plaitpoint-curve of a mixture. The curve constructed according to the rule given will correspond very closely with the actual plaitpoint-curve in the case of all those mixtures, which present the circumstance that a maximum or a minimum tension occurs, if the components have a certain ratio to each other, as is the case with mixtures of N_2O and C_2H_6. The curve for the said mixtures, according to Kuenen's observations, is explained in all its details by this rule.—Prof. Moll on an inquiry by Mr. Van Wisselingh into the nucleolus of *Spirogyra*. The principal results of this inquiry are: (1) besides the usual form of karyokenesis *Spirogyra crassa*, Kütz, has also a second form, in which no nuclear segments are produced; (2) in the division with segmentation ten out of the twelve segments originate in the nucleus itself, while two originate in the nucleolus; (3) in the case of nuclear division with segmentation the nucleolar segments have each a resistant thread, by which they are distinguished from the rest. The resistant threads divide longitudinally, like the segments themselves, and the two halves contribute in the daughter nucleus towards the formation of the new nucleolus. In the case of nuclear division without segmentation the nucleolus also produces two resistant threads, which in the division behave in exactly the same way as in karyokenesis with segmentation.—Mr. Eykman on the influence of the seasons on combustion of nutritive matter in man. The speaker communicated the results of a comparative inquiry into the respiratory exchange of gases in winter and in summer. With the nine persons, upon whom he experimented, the speaker found the average consumption of oxygen, when they were in a state of bodily rest, to be no smaller in summer than in winter, and concludes, also, on the ground of previous investigations made by him in India, that in man there exists no appreciable chemical regulation of heat.—Prof. V. A. Julius presented on behalf of Mr. N. G. van Huffel a short paper on magnetic hysteresis in a long soft iron bar. Round the middle of the bar was a primary coil; a secondary coil could be placed at various distances from the primary one. At a certain moment, varying from 1/3 to 2 seconds after the primary circuit was closed, the secondary one was for $\frac{1}{100}$ second brought in contact with a ballistic galvanometer. It appeared that the rate of change of induction reached a maximum at a certain distance from the middle of the bar, and that the maximum displaced itself with the increase of the time from the middle towards the ends of the bar.—Prof. van Bemmelen communicated on behalf of Mr. Schreinemakers the results of an inquiry into the equilibrium in systems of three components, in which two and three liquid phases occur.—Prof. Kamerlingh Onnes presented on behalf of Dr. W. van Bemmelen a paper, entitled "a provisional notice of new acquisitions of older observations of magnetic variation, among others by Parmentier in 1529, Cavendish in 1587, and by French navigators in the Pacific about the year 1700."—Prof. van der Waals presented (*a*) on behalf of Prof. Dibbits a paper by Dr. A. Smits, on an instrument for keeping the tension above a boiling liquid constant. The space in which the space is to be kept constant, is connected with a U-shaped barometer. When the pressure decreases, the mercury rises in the shorter limb and, in consequence of this, a galvanic circuit is closed, through which a blowing-apparatus is put in action; when the pressure increases, a sucking-apparatus is put in action by another galvanic circuit. When the oscilla-

tions of the mercury are small, the tension can be kept constant within very narrow limits. (*b*) On behalf of Prof. W. Kapteyn a paper on certain definite integrals. According to Cauchy the sum of the residues of a function which is meromorphic within a certain space, may be represented by an integral along the circumference of the space as well as by the sum of the coefficients of the first negative powers of the coefficients of this function in the proximity of the poles. The author applies this principle to a function consisting of the product of $l\left(\frac{1-z}{1+z}\right)^m$ with a function, which is meromorphic within the circumference of a circle described out of the origin with the unit for radius.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 13.

MATHEMATICAL SOCIETY, at 8.—Note on a Property of Pfaffians: H. F. Baker.—On the Stationary Motion of a System of Equal Elastic Spheres of Finite Diameter (continuation): S. H. Burbury, F.R.S.—On Discontinuous Fluid Motion: B. Hopkinson.—On the Intersections of Two Conics of a given Type, and on the Intersections of Two Cubics: H M. Taylor.—On the Continuous Group defined by any given Group of Finite Order: Prof. W. Burnside, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Presentation of Premiums.—Inaugural Address of the President, Joseph W. Swan, F.R.S.

FRIDAY, JANUARY 14.

ROYAL ASTRONOMICAL SOCIETY, at 8.—The Ternary System Lac. 7215 $= h$ 4935: R. T. A. Innes.—The Double Star ζ Bōotis $= \Sigma$ 1865: S. W. Burnham.—The Orbit of OΣ 400: S. W. Burnham.—Note on the Result concerning Diffraction Phenomena recently criticised by Mr. Newall: F. L. O. Wadsworth.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Mechanical Draught: R. Gordon Mackay.

MALACOLOGICAL SOCIETY, at 8.—Note on the Reno-pericardial Pore of *Ampullaria urceus*: R. H. Burne.—On some Points in the Anatomy of *Sepia officinalis*: R. H. Burne.—On an Example of *Acanthoteuthis Férussacii* from the Lithographic Stone of Solenhofen, Bavaria, exhibiting the Buccal Membrane: G. C. Crick.—Descriptions of Four New Species of Land Shells from New Guinea, North Borneo, and Aldabra Island: E. A. Smith.—On the New Land Shells of the Island of Lombock: E. A. Smith.—Description of Two New Species of *Clausilia* from Che-kiang Province, China: Mrs. Kenyon.

MONDAY, JANUARY 17.

SOCIETY OF ARTS, at 4.30.—My Recent Journey from the Nile to Souakim: Frederic Villiers.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Journeys in the East Coast Provinces of Siam: H. Warington Smyth.

VICTORIA INSTITUTE, at 4.30.—The Glacial Epoch: Prof. E. Hull, F.R.S.

TUESDAY, JANUARY 18.

ROYAL INSTITUTION, at 3.—The Simplest Living Things: Prof. E. Ray Lankester, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be further discussed: The Machinery used in the Manufacture of Cordite: E. W. Anderson.

ZOOLOGICAL SOCIETY, at 8.30.—On the Vascular System of the Chiroptera: Dr. N. H. Alcock.—On the General Anatomy of the *Holocephali*: L. W. Byrne.—On the Development of the Hyobranchial Skeleton of the Midwife-Toad (*Alytes obstetricans*): Dr. W. G. Ridewood.

ROYAL STATISTICAL SOCIETY, at 5.30

ROYAL VICTORIA HALL, at 8.30.—Through the New Gold Fields of Alaska to Bering Strait.

WEDNESDAY, JANUARY 19.

SOCIETY OF ARTS at 8.—The Projection of Luminous Objects in Space: Eric Stuart Bruce.

GEOLOGICAL SOCIETY, at 8.—On some Gravels of the Bagshot District: H. W. Monckton.—On the Occurrence of Chloritoid in Kincardineshire: George Barrow.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Ordinary Meeting.——At 7.45.—Annual General Meeting.—Address by the President (E. Mawley) on Weather Influences on Farm and Garden Crops.

ROYAL MICROSCOPICAL SOCIETY, at 8.—President will read his Annual Address.

ENTOMOLOGICAL SOCIETY, at 8.—Annual Meeting.—Address by the President, R. Trimen, F.R.S.

INSTITUTION OF MINING AND METALLURGY, at 8.—Notes on the Action of Cyanogen on Gold: James Park.—Mexican Methods of Mining: S. B. Newall.—On the Successful Treatment of Tailings by the Direct Filling Process on the Witwaterstrand: F. Cardell Pengilly.

THURSDAY, JANUARY 20.

ROYAL SOCIETY, at 4.30.—The Relations between Marine Animal and Vegetable Life: H. M. Vernon.—(1) The Homogeneity of Helium; (2) Fergusonite, an Endothermic Mineral: Prof. W. Ramsay, F.R.S., and Morris W. Travers.—On the Modifications of the Spectra of Iron and other Substances radiating in a Strong Magnetic Field: T. Preston.

ROYAL INSTITUTION, at 3.—The Halogen Group of Elements: Prof. Dewar, F.R.S.

SOCIETY OF ARTS, at 4.30.—Recreations of an Indian Official: Right Hon. Sir Mountstuart Elphinstone Grant Duff, G.C.S.I., C.I.E., F.R.S.

LINNEAN SOCIETY, at 8.—On the Larval Hyobranchial Skeleton of the Anurous Batrachians, with special reference to the Axial Parts: Dr. W. G. Ridewood.—On the "Abdominal Pore" in the Myxinidæ: R. H. Burne.

CHEMICAL SOCIETY at 8.—Ballot for the Election of Foreign Members.—The Action of Caustic Alkalies on Amides: Dr. Julius B. Cohen and Edward Brittain.—The Formation of Monomethylaniline from Dimethylaniline: Dr. Julius B. Cohen and H. T. Calvert.—Note on the Aluminium-Mercury Couple: Dr. Julius B. Cohen and H. T. Calvert.—Action of Chloroform and Alkaline Hydroxides on the Nitro-benzoic Acids: W. J. Elliott.—Researches on the Terpenes. II. On the Oxidation of Fenchene: J. Addyman Gardner and G. B. Cockburn.—The Preparation of Pure Iodine: Dr. Bevan Lean and W. H. Whatmough.

FRIDAY, JANUARY 21.

ROYAL INSTITUTION, at 9.—Buds and Stipules: Sir John Lubbock, Bart., M.P.

PHYSICAL SOCIETY, at 5.—On Electric Signalling without Conducting Wires: Prof. O. Lodge, F.R.S.—A Tesla Oscillator will be exhibited by Prof. S. P. Thompson, F.R.S.

BOOKS AND SERIALS RECEIVED.

BOOKS.—Practical Ethics: Prof. H. Sidgwick (Sonnenschein).—Ordinary Differential Equations: Dr. J. M. Page (Macmillan).—Euclid's Elements of Geometry, Books 1 and 2: C. Smith and Dr. S. Bryant (Macmillan)—Practical Toxicology for Physicians and Students: Dr. P. Kobert, translated and edited by Dr. L. H. Friedburg (New York, Jenkins).—Psalms of the West, 3rd edition (Longmans).—The Tears of the Heliades, or Amber as a Gem: W. A. Buffum, 3rd edition (Low).—A Trip to Venus: J. Munro (Jarrold).—Tabellarische Übersicht der Mineralien: P. Groth, Vierte Vollständig neu Bearbeitete Auflage (Braunschweig, Vieweg).—Third Annual General Report upon the Mineral Industry of the United Kingdom, 1896: Dr. C. le Neve Foster (Eyre).—A Treatise on Chemistry; Roscoe and Shorlemmer. Vol. 2. The Metals, new edition (Macmillan).—Geometry for Beginners: Prof. Minchin, Oxford, Clarendon Press.—From Tonkin to India; Prince Henri d'Orléans, translated (Methuen).—Seventeenth Annual Report of the U.S. Geological Survey, Parts 1 and 2 (Washington).—University College, Sheffield, Calendar for the Session 1897–98 (Sheffield)—The Cyclist's Pocket-Book (Constable).—General Report on the Operations of the Survey of India Department, 1895–96 (Calcutta).

SERIALS.—Scribner's Magazine, January (Low).—Among British Birds in their Nesting Haunts: O. A. J. Lee, Part 8 (Edinburgh, Douglas).—Geographical Journal, January (Stanford).—Observatory, January (Taylor).—Records of the Australian Museum, Vol. iii. No. 3 (Sydney).—The Atoll of Funafuti, Part 5 (Sydney).—Brain, Part 79 (Macmillan)—An Illustrated Manual of British Birds, new edition, January (Gurney).—Bulletin from the Laboratory of Natural History of the State University of Iowa, December (Iowa).—Mind, January (Williams).—Bulletin of the American Mathematical Society, December (New York, Macmillan).—Revue de l'Université de Bruxelles, January-February (Bruxelles).—Knowledge, January (High Holborn).—Records of the Geological Survey of India, Vol. xxx. Part 4 (Calcutta).—Atlantic Monthly, January (Gay).—History of Mankind: F. Ratzel, translated, Part 23 (Macmillan).—Notes from the Leyden Museum, July and October (Leiden, Brill).—Journal of the Asiatic Society of Bengal, Vol. lxvi. Part 2, Nos. 2 and 3 (Calcutta).—Strand Magazine, January (Newnes).—Pearson's Magazine, January (Pearson).—Zeitschrift für Physikalische Chemie, xxiv. Band, 4 Heft (Leipzig).—American Journal of Science, January (New Haven).—American Naturalist, December (Philadelphia).

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THURSDAY, JANUARY 20, 1898.

THE PHYSIC OF OUR FATHERS.

Vita Medica; Chapters of Medical Life and Work. By Sir Benjamin Ward Richardson, M.D., LL.D., F.R.S. Pp. xvi + 496. (London: Longmans and Co, 1897.)

THIS work, Mr. Bertram Richardson tells us, was finished by his father on Wednesday, November 18, 1896, just before eight o'clock in the evening. At ten he was seized with the illness which ended fatally on Saturday morning, November 21. Thus a pathetic interest attaches to these last words of a singularly interesting and gifted man. Not a few errors in the text, such as the misspelling of proper names, and so forth, are due no doubt to the want of the author's revision.

The work may be roughly divided into the biographical part, and a second part in which the author, as if with a prescience of death, tells us of the ideas which had occupied his thoughts in his later years. We trust that we may be forgiven for saying that the former part is by far the more interesting. If Sir Benjamin's style occasionally offend the purist, he nevertheless writes in a vigorous, graphic, and even picturesque fashion, which is far better than mere purity. Although no one would have been more reluctant than the author himself to have his style compared to that of so splendid and accomplished a master of prose as Mr. Ruskin, yet we admit that on reading the first part of this book we were reminded of the charming "Praeterita," in its winning egotism without self-conceit, its happy delineation of character, and its broad humanity. We were greedy of more, and confess to a disappointment when other matters, which the author no doubt regarded as more important, cut short the personal narrative. Not only so, but the narrative itself is diversified by reflections always shrewd and kindly, often acute and original. The admirable portraits of those most interesting of men the old-fashioned country practitioners of medicine—such as Dudley Hudson and Willis—are excellent; in these pages the abler sort of country doctor, with his rugged kindliness, his curious stores of ill-digested learning, his flashes of humorous insight, his devotion to his calling, and his readiness of resource in emergencies, is described to the life. The modern practitioner, however, has some grasp of principles, whereas his predecessor, for the most part, hated ideas; if the modern doctor be inferior to his predecessor in mother wit, less curious in his mental furniture, and wanting in the vigorous eccentricity of manner and thought which made his predecessor entertaining as a character, yet his education in scientific methods makes him a far more enlightened practitioner of a very abstruse and complicated art. We insist on this distinction between the scientific physician and the merely practical doctor, because we think Sir Benjamin Richardson, in his advocacy of the old system of apprenticeship, which no doubt taught well the arts of managing men and horses and of smelling out drugs in the dark of the night, left out of view that cultivation in the broader principles of medicine as a science which nowadays mark the modern practitioner even in country places. For lack of a greater breadth of mental training the Dudley Hudsons, the Willises, and the rest, keenly as they loved curious detail, gained no wide reputation. Moreover, but few apprentices had remarkable men for their teachers; "first catch your despot." The men who stimulated and instructed the young Richardson were singularly able men; too many medical apprentices fell under the guidance of masters whose endowments, natural or acquired, were often little above those of the contemporary cow doctor.

Many points of more than local interest are touched upon in the course of the biographical sketch. Richardson emphasises the part taken by Perry of Glasgow in making known in Great Britain the distinction between enteric and typhoid fevers. Dr. A. P. Stewart, a pupil of Perry, helped to make popular the distinction so clearly taught by his master. The author also gives a very graphic account of the first operation under anæsthetics in Glasgow, by Andrew Buchanan.

Of that remarkable little town Saffron Walden, with its museum and its group of clever men, a very interesting account is given. The Exhibition of 1851 is recalled; and Richardson tells us that its effect—and we may add that of the development of the railways—on the health of women, and consequently on the doctor's income, was one of its unexpected results: women whose lives had been spent in valetudinarianism rose from their sofas, and in the second half of the century forgot that the daily or weekly visits of the doctor had for generations been the principal event in the lives of themselves and such as they. To cycling as a means of health the author gives the same credit. Among other interesting facts he tells us also that he frequently attended in the camps of the gypsies, and found that this nomad way of life was far from a healthy one for the children of these folk In this and innumerable other departments of his life's work the author cannot prevent our perceiving that his devotion to the sick and sorrowful was at least as exemplary as that of those others of the noble band of genera practitioners to whose ranks he then belonged, and whose self-denying labours he has so admirably recorded.

Even in the scientific investigations, which more and more occupied his maturer life, love of man and an earnest desire to benefit his race were prominent. Fruitful as such aspirations are, Richardson might perhaps have done more for science if this love of knowledge had been more disinterested. We must not forget that even Pasteur's work was chiefly inspired by the hope of discovering the means of benefiting his fellow men, yet Richardson was not perhaps wholly free from some tinge of that Philistinism which too often colours the ideas of the benevolent man.

Perhaps Richardson's best work was that on the anæsthetic agents, and on the methods of anæsthesia, whether general or local. In the same spirit he sought a remedy for the terrible effects of clotting of the blood in the heart, or blood-vessels; and certainly the cases quoted by him in support of the method he advised, must command attention. In the sphere of antiseptic surgery, also, he worked hard at a time when its principles were so little understood that the author himself, neither then nor afterwards, was able to lay hold of the principles of bacteriology, on which study he makes adverse and belated reflections. We were unaware that while working at the ethers Richardson had recommended nitrite of

amyl in angina pectoris, a therapeutic discovery which has been attributed to others.

The enthusiasm for humanity which dictated so many of these researches, led Richardson to the front of the battle in the causes of preventive medicine and of teetotalism. His splendid services in the field of sanitary reform are too well known to need record in these columns; his determined advocacy of total abstinence, no doubt, as he tells us, to his own pecuniary detriment, sprang again from his ardent humanity. Whether, right or wrong, he was as a lion in his aweless championship of all measures which, in his opinion concerned the well-being of the masses. At the same time, his report of the social ignominy which overtook those who advocated this unpopular cause, seems to us exaggerated. Higginbottom, of Nottingham, may, of course, have strode down the room at the Provincial Medical Association unregarded and even shunned of men; but the present writer well remembers the honour in which Higginbottom was held by his contemporaries in spite of his determined opposition to the use of alcohol; and the writer, who also enjoyed the friendship of other prominent teetotallers, such as Edward Baines, never heard worse words spoken against these blameless men than that they were the victims of a troublesome whim. In practice the public not unnaturally fight shy of a faddist, as they supposed the teetotaller to be; but, except in the society of topers, surely no teetotaller as such was ever shunned. Sir Benjamin's nephelococcygian dream of the ideal City of Health made a great effect upon the audience to whom the address was given. The earnest purpose and the fervent desire of the orator to benefit mankind gave a reality to a scheme which, of course, he put forward more or less as a phantasy.

In dwelling on the life of Sir Benjamin Richardson we are led to wonder how it was that a man so earnest, so able, so fertile in speculation, so ardent in his laboratory researches should have achieved comparatively little of permanent scientific value. On the other hand, we shall not forget that much of his energy was given to inspiring and directing the men of his time in social work which, if it cannot be formulated, was none the less permanent in its effects. We have hinted that the speculative part of the volume before us is less interesting than the narrative: the thoughts are turned out upon paper in a crude state, and, generally speaking, are no more than the floating thoughts of any able and thoughtful man. Nay, we cannot but feel that in their form we observe the ill effects of the very apprenticeship that he believed to be the best early education for a medical man. We believe that a more systematic training in scientific method in his earlier days would have led not only to a chastening of such speculations, but also to the attainment of scientific discoveries of a more abiding value. Nevertheless, we put down this book with a sense that men of Richardson's stamp—courageous and unwearied in the pursuit of truth—are the salt of our race; and that even in the most unsubstantial of his musings there is always an elevation of tone which reveals the noble and humane character of one so long a familiar figure among us, but whose voice we shall hear no more.

T. C. A.

A NEW WORK ON POPULAR ASTRONOMY.

The Concise Knowledge Astronomy. By Agnes M. Clerke, A. Fowler, A.R.C.S., F.R.A.S., Demonstrator to the Royal College of Science; and J. Ellard Gore, F.R.A.S., M.R.I.A. With illustrations from photographs and drawings. Pp. x + 581. (London: Hutchinson and Co., 1898.)

THIS is a formidable array of authors, and the necessity for such a numerous combination is not at all clear. There is nothing in the book that any one of the three could not have written, and we might add that any one of the three could have written a better book, than the united efforts of the three have produced. While the separate parts, judged from a popular standpoint, are in many respects admirable, there is a want of cohesion in the whole, that is disappointing and unsatisfactory. Collaboration to be effective must be close and thorough; but here, facts are repeated by the separate authors in a way which annoys, and statements are divided between the different writers in a manner which disturbs, a reader. Efficient editing could have prevented a good deal of this overlapping, and have dovetailed the parts together with more skill; but the cumbrous machinery that necessitated an editor at all was a mistake. Can any one suppose that there is any material gain in taking the chapters on the sidereal universe out of Miss Clerke's hands and placing them in those of Mr. Gore, or that Mr. Fowler was incapable of describing the main features of the several members of the solar system? Judging from the result before us, an elementary book is not increased in accuracy nor benefited in arrangement by distributing the compilation among several authors.

Of the trinity here under consideration, Miss Clerke is the largest contributor. To her is entrusted the opening chapters, sketching the history of the science from Hipparchus to the present time. In her hands, a sketch, however brief, is sure to be well arranged and graphically written. We confess, however, to a little disappointment that more space is not given to the development of spectroscopy, and this remark applies not only here but throughout the book generally. Owing to considerations of space it might have been necessary to curtail, or even to exclude, all reference to Mohammedan, and possibly to pre-Newtonian science in these opening chapters; but this loss would have been more than compensated by impressing on the average reader the importance of astrophysics and the part it plays, and in the immediate future, will play, in the development of astronomical science. It must be, no doubt, always a difficult task to know what facts are to be suppressed, and to what others prominence must be given, in order to preserve in due perspective the salient features that mark the onward progress of a science. But full advantage has not been taken of the marvellously rapid development of astrophysics to make it an incentive to the study of astronomy. The facts, and possibly the speculations, of spectroscopy have a great fascination for the general reader. The results can be presented without reference to mathematical formulæ, and by the powerful appeal they make to the imagination, they are eminently calculated to excite public enthusiasm and arouse an intelligent

interest in the community. Surely one of the objects, if not the main object of such a book as this, is to promote the cultivation of the science among an instructed, but not specially instructed, public. For whom else is the book written? It is not a work of reference intended to be used by the astronomer; it is not sufficiently full. The earnest student of astronomy is catered for by treatises of a more serious character. In point of fact the book occupies, to some extent, the ground which Sir Robert Ball has so well covered, and appeals generally to the same class of readers.

Another disadvantage springs from this slight, and Miss Clerke must pardon us if we say, unworthy, sketch of spectroscopic advance. Justice is not accorded to those who have worked strenuously and successfully as pioneers in this branch of science. One unacquainted with the history of the science might suppose that our knowledge of it began and ended with the work of Sir William Huggins. We do not mean to imply that there is one word here that is not justified by his great reputation, but only to regret that the names of other equally earnest and equally capable workers are suppressed. We think the omission of all reference to the work of other physicists, both at home and abroad, makes the survey of the general progress of the science too incomplete, and might indeed be likened to the representation of Hamlet with the omission of the Prince of Denmark. No doubt the prominence given to some astronomers, and the silence maintained with regard to others, are accidental; but it unfortunately suggests that the author's mind is warped in special directions, preventing a wholly unprejudiced survey being taken, and suggesting a biassed arrangement of the facts. Happily, in such an elementary work, when we come to greater detail, points still open to controversy and further elucidation do not come before us. We have only to deal with admitted and recognised truths, and here Miss Clerke is a safe guide. The section describing the solar system leaves little to be desired; few could probably have arranged an equal number of facts in the same space without becoming dull and wearisome. By the admirable illustrations supplied, we are in some instances enabled to see the planets and the details of their surface markings as they are revealed in the most powerful telescopes, while the latest views and speculations of the observers are recorded with ample fulness. We anticipate that on this section the general reader will dwell with the greatest interest and delight.

Mr. Fowler's work, without much reason, is sandwiched in between the preliminary historical chapter and this description of the solar system. It is termed geometrical astronomy, not a very happy title, but spherical was, no doubt, felt to be too ambitious a description, and it certainly does deal with many of the problems that belong to the earth's figure and motions. Trigonometrical expressions are practically excluded, but by the aid of diagrams a good many simple problems are very satisfactorily explained. The description of instruments is an interesting feature in this section, and is written with that simplicity and clearness which characterises all Mr. Fowler's work when dealing with mechanical operations.

Mr. Gore furnishes the last part of this trilogy. His domain is the sidereal heavens, and, considering the space at his disposal, his work is very thoroughly done. We could have wished, and so possibly did Mr. Gore, that he had been allowed to use Greek letters to designate the stars in their respective constellations. An uncomfortable strange appearance is given to many old friends dressed up in this unfamiliar fashion. But when one gets over this peculiarity it will be found that the facts connected with binary systems, with temporary and variable stars, with the motion of the sun are clearly and accurately stated, and give a very complete idea of the present condition of our knowledge of the sidereal heavens.

A few very obvious errors are occasionally met with in the course of the book; but where so much has been read with pleasure, it seems a very ungracious task to place the finger on these few blots, which, no doubt, will disappear in subsequent editions. If any one prides himself on his accuracy, let him write an elementary textbook on a subject in which the facts are continually accumulating, and the deductions from them being constantly modified, and he will probably find that his self-complacency is scarcely warranted. W. E. P.

OUR BOOK SHELF.

Manuel d'analyse chimique appliquée a l'examen des produits industriels et commerciaux. By Émile Fleurent. Pp. iii + 582. (Paris: G. Carré et C. Naud, 1898.)

THE author states in his preface that he has written with a threefold aim, namely: (1) to give general methods of qualitative and quantitative mineral analysis and organic analysis of an elementary character, free from all details not absolutely useful; (2) to avoid methods of work that are too long for those who are pressed for time or who have not sufficient general knowledge, giving in each case only one method (or occasionally two) that leads quickly and surely to the desired result; and (3) to bring together in one volume the methods of examination of *the more important*, though the most diverse of the products which one meets with in the laboratory of the industrial chemist. Accordingly we find in some 556 pages of clearly printed and well-spaced matter some preliminary observations with reference to apparatus, a section on qualitative analysis, and methods for the quantitative examination of the commoner metals and minerals containing them, besides, among other things, water, inorganic pigments, cements, &c., compounds of the alkalis, manures of various kinds, soils, animal and vegetable products, such as cellulose, tannin, milk, fruits, fermented liquors, wines, and textile fabrics, the estimation of acetone in methylated spirit, and the determination of the flashing point of petroleum, &c. It is obvious that where so much ground is covered in so comparatively small a space, that in some cases at least there cannot be room for more than a mere summary of the details of the method given. It is generally a matter of opinion as to which is the best of several alternative methods, and often, too, a slight variation in the sample from what is most usual, renders a variation in the process desirable. It must have been a very difficult task to select the one or two methods in each case; but, taken as a whole, they are fairly representative. If the space devoted to the figures of beakers and other apparatus, and to the exceedingly meagre description of the qualitative reactions of the common acids and bases had been devoted to an expansion of the other part of the book, the usefulness of the volume would have been much increased. We doubt, for example, the need for telling any one who concerns himself with such work as is here described, that

mercuric salts give a precipitate with sulphuretted hydrogen which changes from white to black, and is insoluble in alkaline sulphides; that hydrochloric acid and chlorides give no precipitate, and that iodide of potassium gives a beautiful red precipitate very soluble in excess of the reagent. These are all the qualitative reactions given for mercuric salts, and it may well be said of them that, though true, they are not the whole truth even concerning the precipitates mentioned. As a reminder for students who have to learn what they can about many things in a very little time, the volume will no doubt prove very valuable, and the practical analyst will sometimes find suggestions that will prove useful to him.

First Book of Physical Geography. By Ralph S. Tarr, B.S., F.G.S.A. Pp. xxviii + 368. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897.)

PROF. TARR explains that his reasons for following his "Elementary Physical Geography" (noticed in NATURE, vol. liii. p. 293) by the present smaller work, is that "many teachers who wish to give instruction in the *new physical geography* are unable to make use of it," on account, apparently, of the educational regulations in the United States. Although Prof. Tarr italicises the *new physical geography*, we are unable to see that this book differs essentially in subject-matter from such a long established schoolbook as Geikie's "Elementary Lessons in Physical Geography"; and although with regard to arrangement and style there are variations, these present no special novelty.

Part i. deals with the earth as a whole, and some facts of astronomy; Part ii.—entitled "The Atmosphere"—also touches on light, heat, electricity, magnetism, and the distribution of animals; Part iii. treats of the ocean; and Part iv. of the land. The last part is by far the best from every point of view, and the treatment of the action of rivers on the land is quite beyond anything we have seen in other books of similar scope. This department of physical geography has received more attention in America than in Europe, and we are grateful to Prof. Tarr for the way he has handled it. It is unfortunate that the other parts do not rise to the same level. The illustrations, however, are all very good.

No doubt some terms are used in a different sense in this country and in America, *e.g.* physiography, which here is wider than physical geography, is there restricted to geomorphology. It appears that *zone* is held to signify simply a division, *e.g.* "there are three great zones of life . . . the ocean, the land, and the fresh water" (p. 165); and "in lieu of" (p. 27) is used where we would say "in view of." The term adulteration, on p. 33 ("nitrogen . . . acts as an adulterant to the active oxygen in a manner similar to the adulteration or weakening of a solution of salt when water is added to it"), is used evidently in the sense of dilution, and is not intended to convey any suggestion of fraudulent mixture. But, making allowance for differences of custom in the use of words, we have noted several cases of very slack or even careless definition. There is also a want of attention to the minutiæ of terminology which must be very puzzling to the teachers who use this book, if their mode of doing so is the same as that adopted by their brethren in this country. In a new edition these blemishes will doubtless disappear, and we point them out merely with that object. Such vague sentences as the following, on wind as the cause of waves, should also be revised: "If the wind continues, and especially if it freshens, the waves become higher, for the cause is increased because then there is more friction" (p. 206).

The occasional descriptions of instruments, *e.g.* the psychrometer, anemometer, and especially the deep-sea sounding-rod, are inadequate and sometimes misleading. On the current chart (p. 214) the important and very distinct Agulhas current is not named; and in the sketch-map of the distribution of volcanoes, on p. 355, the active volcanoes which have been definitely proved to exist in Central Asia and Central Africa are not shown.

H. R. M.

Arii e Italici. By G. Sergi. Pp. iv + 228. (Torino: Fratelli Bocca, 1898.)

PROF. SERGI may be congratulated on the lucid manner in which he describes the earliest inhabitants of Italy, and the effects produced by the various invasions of that country. From conclusions drawn from anthropological observations he leads us to believe that the Aryans first invaded Italy from the north-west, and established themselves on the banks of the river Po, terramara being found in that locality. These mixed with the Mediterranean race, and spread south-east, leaving the country around Genoa undisturbed; towards the end of the eighth century before the Christian era, the Etruscans landed on the banks of the Tiber and mixed with the inhabitants of Umbria. No satisfactory explanation of the foundation of Rome is offered.

Anthropological detail is restricted to skulls found in tombs; the method of description is that first introduced by the author, which is based upon the appearance of the skull viewed in *norma verticalis.*

The construction of terramara and lake dwellings, the various kinds of pottery and vases, are briefly described in the chapters dealing with archæology.

The origin of the Italian language and the anthropological evidence in favour of the suggestions of Schleicher, Lottner, &c., is carefully weighed.

It would assist the study of ethnology if the inhabitants of the other European countries were dealt with in as brief and scientific a manner as those of Italy have been by Sergi in "Arii e Italici."

Laboratory Practice for Beginners in Botany. By William A. Setchell, Ph.D., Professor of Botany in the University of California. Pp. xiv + 199. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1897.)

THIS little book is, on the whole, admirably calculated to fulfil the intentions of its author. The young student is directed to observe simple and readily accessible objects, and his reasoning faculties are at the same time stimulated by an indication of the general principles which the selected examples are intended to illustrate. By the time he has worked through the book, a boy will have acquired a fair knowledge of the gross structure of plants—a knowledge quite as important as that of minute structure which he too often has never seen for himself, or of physiology which, when ignorant of chemistry and physics, he cannot understand.

Some of the suggestions to the teacher are excellent, but we can hardly praise the selection of literature suggested for his use. A teacher ought to know where to seek for the facts he may have temporarily mislaid; and if he really requires the aid Prof. Setchell is ready to render him in this respect, he is clearly unfit to teach.

"*On a Sunshine Holyday.*" By the Amateur Angler. Pp viii + 140. (London: Sampson Low, Marston, and Co., 1897.)

THE short—very short—papers collected in this booklet originally appeared in the *Fishing Gazette.* The author confesses that he is "well aware that from the standpoint of literature these papers possess no claim for a separate existence." He might also have added that, from a scientific point of view, there is even less justification for their publication.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Abridged Long Division.

A Brief Method of dividing a given Number by a Divisor of the Form ($h.\ 10^n \pm k$), *where at least* one *of the two numbers, h and k, is greater than* 1.

MY former paper on this subject, which appeared in NATURE for October 14, 1897, dealt only with the case where $h = 1$ and $k = 1$. It elicited, from other correspondents of NATURE, several interesting letters, which the editor kindly allowed me to see. One, from Mr. Alfred Sang, quotes Mons. L. Richard's "Sténarithmie," as containing my Rule for dividing by 11. Mons. Richard's book, which I had not previously met with, does certainly contain the rule, but the author has failed to see that the test, which this Method furnishes, for the correctness of the working, is absolutely *definite*. He says "La dernière difference, ou cette difference augmontée de 1, égalera le chiffre de gauche du nombre proposé." So ambiguous a test as this would of course be useless. But the "difference" he is speaking of is really the *last but one*: the very *last* will always (as I stated in my former paper) be equal to zero. Another correspondent, Mr. Otto Sonne, says that my Rules, both for 9 and for 11, are to be found in a school-book, by a Mr. Adolph Steen, which was published at Copenhagen in 1847. So I fear I must reduce my claim, from that of being the first to discover them, to that of being the first to publish them in English.

The Method, now to be described, is applicable to three distinct cases:—

(1) where $h > 1$, $k = 1$;
(2) where $h = 1$, $k > 1$;
(3) where $h > 1$, $k > 1$.

With certain limitations of the values of h, k, and n, this Method will be found to be a shorter and safer process than that of ordinary Long Division. These limitations are that neither h nor k should exceed 12, and that, when $k > 1$, n should not be less than 3: outside these limits, it involves difficulties which make the ordinary process preferable.

In this Method, two distinct processes are required—one, for dealing with cases where $h > 1$, the other, for cases where $k > 1$. The former of these processes was, I believe, first discovered by myself, the latter by my nephew, Mr. Bertram J. Collingwood, who communicated to me his Method of dealing with Divisors of the form ($10^n - k$).

In what follows, I shall represent 10 by t.

Mr. Collingwood's Method, for Divisors of the form ($t^n - k$), may be enunciated as follows:—

"To divide a given Number by ($t^n - k$), mark off from it a period of n digits, at the units-end, and under it write k-times what would be left of it if its last period were erased. If this number contains more than n digits, treat it in the same way; and so on, till a number is reached which does not contain more than n digits. Then add up. If the last period of the result, *plus* k-times whatever was carried out of it, in the adding-up, be less than the Divisor, it is the required Remainder; and the rest of the result is the required Quotient. If it be not less, find what number of times it contains the Divisor, and add that number to the Quotient, and subtract that multiple of the Divisor from the Remainder."

For example, to divide 8678159248570315276 4092 by 9993 (*i.e.* by $t^4 - 7$), he would proceed thus:—

9993 ‖	867	8159	2485	7031	5276	4092
		6074	7114	7399	9220	6932
		4	2522	9803	1799	4540
			29	7660	8622	2593
				208	3626	0354
					1458	5382
					1	0206
						7
Quot.	868	4238	2153	2104	0004 ‖	4106 + 14 = 4120 Rem.

The new Method will be best explained by beginning with case (3): it will be easily seen what changes have to be made in it when dealing with cases (1) and (2).

The Rule for case (3), when the sign is "−," may be enunciated thus:—

Mark off the Dividend, beginning at its units-end, in periods of n digits. If there be an overplus, at the left-hand end, less than h, do not mark it off, but reckon it and the next n digits as one period.

To set the sum, write the Divisor, followed by a double vertical: then the Dividend, divided into its periods by single verticals, with width allowed in each space for ($n + 2$) digits. Below the Dividend draw a single line, and, further down, a double one, leaving a space between, in which to enter the Quotient, having its units-digit below that of the last period but one of the Dividend, and also the Remainder, having its units-digit below that of the last period of the Dividend. In this space, and in the space below the double line, draw verticals, corresponding to those in the Dividend; and make the last in the upper space double, to separate the Quotient from the Remainder.

For example, if we had to divide 5984407103826 by 6997 (*i.e.* $7.\ t^3 - 3$), the sum, as set for working, would stand thus:—

6997 ‖	5984 |	407 |	103 |	826	
	Quot. |	|	‖		Rem.
	|	|	|		

To work the sum, divide the 1st period by h: enter its quotient in the 1st Column below the double line, and place its Remainder above the 2nd period, where it is to be regarded as *prefixed* to that period. To the 2nd period, with its prefix, add k-times the number in the 1st Column, and enter the result at the top of the 2nd Column. If this number *is not* less than the Divisor, find what number of times it contains the Divisor, and enter that number in the 1st Column, and k-times it in the 2nd; and then draw a line below the 2nd Column, and add in this new item, deducting from the result t^n-times the number just entered in the 1st Column; and then add up the 1st Column, entering the result in the Quotient. If the number at the top of the 2nd Column *is* less than the Divisor, the number in the 1st Column may be at once entered in the Quotient. The number entered in the Quotient, and the number at the foot of the 2nd Column, are the Quotient and Remainder that would result if the Dividend ended with its 2nd period. Now take the number at the foot of the 2nd Column as a new 1st period, and the 3rd period as a new 2nd period, and proceed as before.

The above example, worked according to this Rule, would stand thus:—

		6	5	3	
6997 ‖	5984	407	103	826	
Quot.	855	281	849 ‖	6373	Rem.
	854	8969	5946		
	1	3			
			849		
		1972			
		281			

the Mental Process being as follows:—

Divide the 5984 by 7, entering its Quotient, 854, in the 1st Column, and placing its Remainder, 6, above the 2nd period. Then add, to the 6407, 3-times the 854, entering the result in the 2nd Column, thus. "7 and 12, 19." Enter the 9, and carry the 1. "1 and 15, 16." Enter the 6, and carry the 1. "5 and 24, 29." Enter the 9, and carry the 2, which, added to the prefix 6, makes 8, which also you enter. Observing that this 8969 *is not* less than the Divisor, and that it contains the Divisor *once*, enter 1 in the 1st Column, and 3-times 1 in the 2nd, and then draw a line below, and add in this new item, remembering to deduct from the result 7-times t^3, *i.e.* 7000: the result is 1972. Then add up the 1st column, as far as the double line, and enter the result, 855, in the Quotient. Now take the 1972 as a new 1st period, and the 3rd period, 103, as a new 2nd period, and proceed as before.

The Rule for case (3), when the sign is "+," may be deduced from the above Rule by simply changing the sign of k. This will, however, introduce a new phenomenon, which must be provided for by the following additional clause:—

When you add, to the 2nd period with its prefix, ($-k$)-times

the number in the 1st Column, *i.e.* when you *subtract* k-times this number *from* the 2nd period with its prefix, it will sometimes happen that the subtrahend exceeds the minuend. In this case the subtraction will end with a *minus* digit, which may be indicated by an asterisk. Now find what number of Divisors must be added to the 2nd Column to cancel this *minus* digit, and enter that number, marked with an asterisk, in the 1st Column, and that multiple of the Divisor in the 2nd; and then draw a line below the 2nd Column, and add in this new item.

As an example, let us take a new Dividend, but retain the previous Divisor, changing the sign of k, so that it will become 7003 (*i.e.* $7.\ t^3+3$). The sum, as set for working, would stand thus:—

```
7003 || 6504 | 318 | 972 | 526
Quot.        |     ||        Rem.
        ___________________
             |     |     |
```

After working, it would stand thus:—

```
                     1      4      5
7003 || 6504  |    318 |  972 |  526
Quot.   928   |    790 |  371 || 4413  Rem.
       _______________________________
        929   | 2*531  | 2602 |
         1*   | 7 003  | ==== |
              | ------ |  371 |
              | 5 534  |
              | ====== |
              |   790  |
```

the Mental Process being as follows:—

Divide the 6504 by 7, and enter the Quotient, 929, in the 1st Column, and the Remainder, 1, above the 2nd period. Then subtract, from the 1318, 3-times the 929, entering the result in the 2nd Column, thus. "27 from 8 I ca'n't, but 27 from 28, 1." Enter the 1, and carry the borrowed 2. "8 from 1 I ca'n't, but 8 from 11, 3." Enter the 3, and carry the borrowed 1. "28 from 3 I ca'n't, but 28 from 33, 5." Enter the 5, and carry the borrowed 3. "3 from 1, *minus* 2." Enter it, with an asterisk. Observing that, to cancel this *minus* 2, it will suffice to add *once* the Divisor, enter a (−1) in the 1st Column, and 7003 in the 2nd; and then draw a line below the 2nd Column, and add in this new item: the result is 5534. Then add up the 1st Column, and enter the result, 928, in the Quotient. Now take the 5534 as a new 1st period, and the 3rd period, 972, as a new 2nd period, and proceed as before.

The Rules for case (2) may be derived, from the above, by making $k=1$; and those for case (3) by making $h=1$. I will give worked examples of these; but it will not be necessary to give the Mental Processes.

By making $k=1$, we get Divisors of the form $(h.t^n \pm 1)$: let us take $(11t^4 - 1)$ and $(6t^5 + 1)$.

```
                           9         10        4
109999 || 107523 |      8168 |     9662 |   0985
Quot.      9774  |      9813 |     0861 | 41846  Rem.
          ______________________________________
           9774  |    107942 |   119474 |
                 |    ====== |        1 |
                 |      9812 |   ------ |
                 |         1 |     9475 |
                             |   ====== |
                             |      861 |

                      3                       3
600001 || 7239 |  51798    |  2 6004 |   13825
Quot.     1206 |  58431    |  9 4595 || 219230  Rem.
         _____________________________________
               |  350592   |  4*7572 |
               |  ======   | 60 0001 |
               |   58432   | ------- |
               |      1*   | 56 7573 |
                           | ======= |
                           |  9 4595 |
```

In this last example, there is no need to enter the Quotient, produced by dividing the 7239 by 7, in the 1st Column: we easily foresee that the number at the top of the 2nd Column *will be* less than the Divisor, so that there will be no new item in the 1st: hence we at once enter the 1206 in the Quotient.

By making $h = 1$, we get Divisors of the form $(t^n \pm k)$: let us take $(t^4 - 7)$ and $(t^5 + 12)$.

```
9993 || 867 | 8159 | 2485  | 7031  | 5276  | 4092
Quot.   868 | 4238 | 2153  | 2104  | 0004  | 4120  Rem.
       ___________________________________________
        867 | 14228 | 32130 | 22088 | 19990 |
          1 |     7 |    21 |    14 |    14 |
            | ----- | ----- | ----- | ----- |
            |  4235 |  2151 |  2102 |     4 |
            |     3 |     2 |     2 |

100012 || 7185 | 6 2039  |  10327 | 53118
          7184 | 7 5822  |  00463 | 47562
         _________________________________
          7185 | 3*5819  | 9*00355 |
            1* | 10 0012 | 9 00108 |
               | ------- | ------- |
               | 7 5831  |     463 |
               |     9*  |
```

The first of these two sums is the one I gave to illustrate Mr. Collingwood's Method of working with Divisors of the form $(t^n - k)$.

It may interest the Reader to see the 3 Methods of working the above example—ordinary Division, Mr. Collingwood's Method, and my version of it—compared as to the amount of labour which each entails in the working:—

	Ordinary Division.	Mr. C.'s Method.	My version of it.
Digits written:	202	82	44
Additions, or Subtractions:	204	97	25
Multiplications:	0	70	22

I am assuming that any one, working this example by ordinary Division, would begin by making a Table of Multiples of 9993, for reference: so that he would have *no* Multiplications to do. Still, the great number of digits he would have to write, and of Additions and Subtractions he would have to do, involving a far greater risk of error than either of the other Methods, would quite outweigh this advantage.

By whatever process a Question in Long Division has been worked, it is very desirable to be able to test, easily and quickly, the correctness of the Answer. The ordinary test is to multiply together the Divisor and Quotient, add the Remainder, and observe whether these together make up the given Number, as they ought to do.

Thus, if N be the given number, D the given Divisor, Q the Quotient, and R the Remainder, we ought to have

$$N = D.Q + R.$$

This test is specially easy to apply, when $D = (h.t^n \pm k)$; for then we ought to have

$$N = (h.t^n \pm k).\ Q + R;$$
$$= (hQ.t^n + R) \pm kQ.$$

Now $hQ.t^n$ may be found by multiplying Q by h, and tacking on n ciphers. Hence $(hQ.t^n + R)$ may be found by making R occupy the place of the n ciphers. If R contains less than n digits it must have ciphers prefixed; if more, the overplus must be carried on into the next period, and added to hQ.

Having found our "Test," viz. $(hQ.t^n + R)$, we can write it on a separate slip of paper, and place it below the working of the example, so as to come vertically below N, which is at the top. When the sign in D is '−,' we must add kQ to N, and see if the result $= T$; when it is '+,' we must add kQ to T, and see if the result $= N$.

Now it has been already pointed out that when, in the new Method, the 1st and 2nd Columns have been worked, the 1st period of the Quotient and the number at the foot of the 2nd Column are the Quotient and Remainder that would result if the Dividend ended with its second period. Hence the Test can be at once applied, before dealing with the 3rd Column. This constitutes a very important new feature in my version of Mr. Collingwood's Method. Every two adjacent columns contain a separate Division-sum, which can be tested *by itself*. Hence, in working my Method, as soon as I have entered the 1st period of the Quotient, I can test it, and, if I have made any mistake, I can correct it. But the hapless computator, who has spent, say, an hour, in working some gigantic sum in Long Division—

whether by the ordinary process or by Mr. Collingwood's Method—and who has chanced to get a figure wrong at the very outset, which makes every subsequent figure wrong, has no warning of the fatal error till he has worked out the whole thing "to the bitter end," and has begun to test his Answer. Whereas, if working by *my* Method, he would have been warned of his mistake almost as soon as he made it, and would have been able to set it right before going any further.

As an aid to the Reader, I will give the Mental Process in full, for the 2nd and 3rd Columns of the first of the examples worked above.

The Divisor is 6997 (where $h = 7$, $k = 3$). Here you are supposed to have just entered the 281 in the Quotient. The Dividend, for these 2 Columns, is 1972 | 103; the Quotient is 281, and the Remainder 5946. The Test is $hQ.t^n + R$, (*i.e.* $7 \times 281000 + 5946$), the Mental Process being as follows. You write, on a separate slip of paper, the last 3 digits of R, viz. 946, and carry the 5 into the next period, adding it to the 7×281: thus. "5 and 7, 12." Enter the 2, and carry the 1. "1 and 56, 57." Enter the 7, and carry the 5. "5 and 14, 19." Enter it. Having got your Test, try whether $(N + kQ)$ is equal to it. This you compute, comparing it with your Test, digit by digit, as you go on, thus. "3 and 3, 6." Observe it in the Test. "0 and 24, 24." Observe the 4, and carry the 2. "3 and 6, 9." Observe it. "1972 and 0, 1972." Observe it. The Test is satisfied.

6	5
407	103
281	
8969	5946
3	
1972	
281	
Test 1972	946

For Divisors of the form $(t^n \pm k)$ there is no need to write out the Test: the numbers, which compose it, already occur in the working, and may be used as they stand.

CHARLES L. DODGSON.

Ch. Ch., Oxford, December 21, 1897.

Optical Illusions produced by Observation of Rotating Spirals.

IT is well known that if a spiral, such as represented in the figure, rotating in the opposite direction to the movement of the hands of a clock, be observed for some minutes, an impression of circles arising at the centre and disappearing at the periphery is produced; after protracted observation, on looking at printed matter or a person's face, the letters appear to move towards the centre while the face appears to become smaller and recede. If the spiral be rotated in the opposite direction, the circles

appear to be passing towards the centre, in which case the after-effect is more marked and lasts longer, the letters naturally pass centrifugally while the face apparently increases in size.

The latter effect in my own observations has sometimes continued for fifty seconds, while the former never for more than twenty seconds. This effect is practically the same as the "waterfall phenomenon," in which case the banks appear to move upwards after gazing for some time at the falling water.

What I wish to draw attention to in this note is the effect which may be observed on closing the eyes after watching a well-illuminated rotating spiral.

If the direction of rotation has produced the impression of centripetally travelling rings, a star composed of radial lines consisting of small granular patches of light passing centrifugally will be noted for a second or two after closing the eyes. The granules pass centripetally if the direction of rotation be reversed. The star will appear symmetrical if the spiral be viewed normally, but if sideways the lines composing it will be curved and the star distorted: to some observers the centre of the star always appears to be further distant than the periphery. I have not been able to find any difference in time of duration of this after-image on rotating the spiral in the two directions.

The colour of the granules is always yellowish, whatever be the colour of the spiral and background. It is interesting to note that, as a rule, after-images of central production can be prophesied on psychological reasoning; while in the above case no one to my knowledge has been able to foretell the appearance of the star, and therefore I am inclined to think that the effect is retinal.

O. F. F. GRÜNBAUM.

Poisonous Koda Millet.

THERE have been several well-ascertained examples of poisoning from diseased or improperly-prepared *Koda* millet (*Paspalum scrobiculatum*) during the past year in India. Owing to the prevailing scarcity of the usual food-grains, it is probable that *Koda* millet has been extensively sold and eaten in localities where its use is ordinarily unknown.

I hoped to undertake an investigation myself into this matter, which is one of great importance both from the hygienic and economic points of view. After consultation, however, with Surgeon-Major van Geyzel, chemical examiner to the Government of Madras, I have decided that any investigation worthy of the name would occupy far more time than I have to give to it. I therefore write to you with a view to eliciting the help of some worker in Britain or elsewhere who has the necessary leisure and facilities for work of this sort. I have samples of the grain, husked and unhusked, from different localities, and can supply the necessary references to the literature of the subject. The investigation, I take it, would have to be of a chemico-biological nature, and would be most appropriate, say, for a thesis, or in connection with some fellowship. I hope that some one who can carry the work right through, and will ascertain the exact source and constitution of the poison (? a volatile alkaloid), will write to me at the address given below. In another ten years, perhaps, there will be some attempt to provide the men and the facilities for such work, even in India, when the Victoria Institute is an accomplished fact.

A. E. GRANT.

Hygiene Laboratory, Medical College, Madras.

Hermaphroditism in the Herring.

I WISH, with your permission, to record a singular "freak of nature" and, at the same time, to ask whether any similar observation has been made by others.

Some fresh herrings were served us here last evening for dinner, and among them was one which, on being opened, disclosed a roe, half of which was "hard" and the other half "soft." The ova and milt were respectively quite normal in appearance (and flavour), and melted imperceptibly one into the other about midway in the length of the roe, which was, itself, in an obviously natural and undisturbed condition.

Sea Lawn, Torquay, January 12. DAN. PIDGEON.

A Bright Meteor.

ON Sunday night (December 12), at about 8.15, I witnessed the appearance of a magnificent meteor which seemed to travel from the south-east in the direction of Ursa Major. It broke up into a number of fiery balls of most brilliant colours. The atmosphere was clear and frosty and the moon very bright, but it was for the moment quite eclipsed by the brilliancy of this striking meteoric display. This may be the same phenomenon as that referred to in NATURE for January 6 (see page 228). I did not hear any sound like thunder at the time.

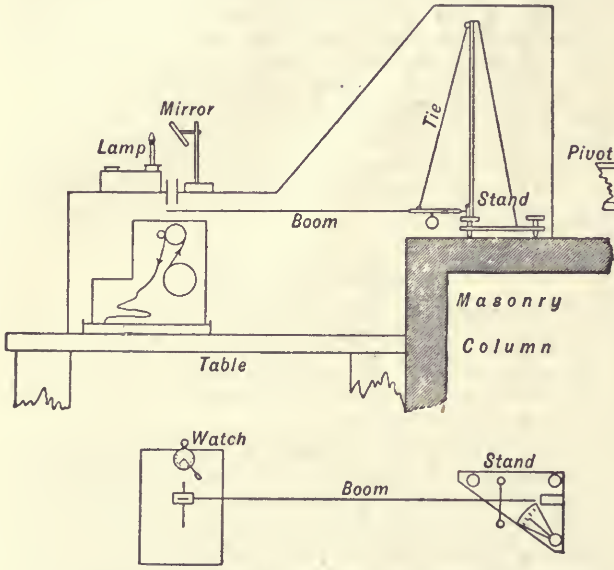
SUSANNA LEHMANN.

Wales Lodge, Wales, Sheffield, January 16.

RECENT SEISMOLOGY.[1]

II.—UNFELT MOVEMENTS OF THE EARTH'S CRUST.

THE records obtained from seismographs often showed, as we have already explained, preliminary vibrations performed with a rapidity which has even reached fifteen complete back and forth movements per second, a shock or shocks, and lastly a number of irregular jolts or



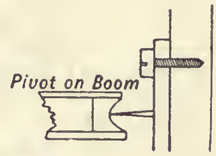


FIG. 7.—Type of instrument adopted by the Seismological Investigation Committee of the British Association, and established at many stations round the world. (Milne.)

undulations which died away with an increasing period. What seismologists had captured was what they could feel, and they were left to speculate as to what came at either extremity of the seismic spectrum. It seemed tolerably certain that if instruments were constructed capable of responding to exceedingly rapid but minute elastic vibrations, then a seismogram might show the movements preceding but forming portions of the preliminary vibrations. These would accompany the sound waves which in rocky districts so commonly outrace movements of a more pronounced character. These sound phenomena, which never extend far beyond an epifocal area, are in certain districts isolated phenomena which frequently recur. Without calling up the "spooks of Ballechin," or the Ghost of Long Wittenham, which on New Year's Eve rapped on the walls of many houses, in two instances we are assured that they have been sufficient to explain noises which had been regarded as supernatural, and it is not unlikely that the fully-equipped ghost hunter may be the discoverer of new paths in seismic science. When a volcano explodes, the resultant vibrations to which ordinary seismographs or ourselves are sensible, seldom reach to any great distance; but is it not possible that elastic tremors, the result of a powerful impulse, may even reach and be focussed at the antipodes of their origin? In the Perry-tromometer we have an apparatus which will automatically record elastic vibrations of the order here considered, but up to the present we are without the observer who is able to isolate himself at a site suitable for its installation. In the Isle of Wight the writer found that this instrument recorded the firing of cannon at a distance of six miles, the movements of trains at a distance of nearly one mile, the rumbling of carriages at the distance of a quarter of a mile, whilst it kept an excellent tally of the back and forth journeys of eleven gravel carts worked by a neighbouring contractor.

Investigations on the other end of the seismic spectrum have been more successful, and we now know that waves which have a period of one or two seconds within the area where they are appreciable to the senses, after these have radiated to great distances, for example over or through a quadrant of the earth, their period may exceed twenty seconds. In consequence of the slowness of the movements, together with the flatness of the waves, which are probably miles in length with heights measured by a few inches, every city in the world is often rocked slowly to and fro, and yet to the unaided senses motion is imperceptible.

A form of instrument used by the writer to record unfelt earthquakes, diurnal waves, tremors and other movements is shown in Fig. 7. On the outer end of the boom of the pendulum there is a small aluminium plate in which there is a slit. This is free to float to the right or left over a slit in the lid of a box in which clockwork drives a band of bromide paper. Light from a lamp passing through the two crossed slits reaches the paper as a point, and gives a line with extremely fine definition (see Fig. 8, under the words September 21). At each half-hour the minute hand of a watch crosses one end of the slit, and by eclipsing the light gives the hour marks shown in Fig. 8.

In the photograms of these unfelt earthquakes we see that the duration of the preliminary tremors is apparently connected with the distance the disturbance has travelled, and in this way a record has impressed upon it what is partially equivalent to the post-mark of its origin. For example, a disturbance originating in Japan would at a distance of, say, 200 km., be heralded by tremors which an ordinary seismograph would show to have a duration of ten or twenty seconds. A seismogram of the same shock taken in Europe shows that the same movements have a duration of about half an hour. The maxima phases of movements, which may be waves of distortion modified by gravity, travel at approximately

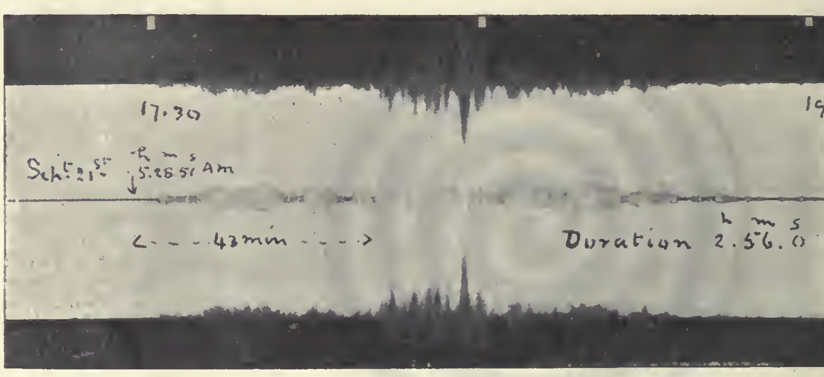


FIG. 8.—This earthquake of September 21, 1897, as recorded in the Isle of Wight, shows preliminary tremors of about 43 minutes, which indicate an origin at a distance of 112°, say, east of Borneo. It disturbed magnetographs in Batavia. A similar earthquake ten hours earlier is not known to have done so. (Milne.)

[1] Continued from p. 249.

the same rate of 2 or 3 km. per second over paths which are long or short. The preliminary vibrations, in all likelihood representing waves of compression, appear to have velocities of propagation closely related to the length of the path as measured on an arc over or across which they have been propagated. Such figures as we have, which are open to correction after observations have been extended, are easily remembered. Starting with a velocity of 2 km. per second for a path of 2000 km., then for a path of 4000 km. the velocity would be 4 km. per second, from Japan to England, or 9000 km., the velocity would be 9 km. per second; whilst, if we may carry conclusions beyond the limits of observation, we may imagine that the velocity of propagation between an origin and its antipodes may be 18 km. per second. As Mr. J. Larmor pointed out, if our records are correct, then outside our first 2000 km. coseismal, great disturbances will be recorded at all points on the surface of the world at approximately the same instant. Undoubtedly velocities of 9 and 10 km. per second have been noted, which indicate that the preliminary vibrations, at least, can not have been transmitted round the heterogeneous and broken materials constituting the earth's crust, but rather, that the movements have passed along direct, or by refraction along curvilinear paths *through* the interior of our earth. This fact, taken in conjunction with the fact that velocities of transmission increase with an increase in the length of the wave path, and that at any given station two sets of vibration separated by a time interval proportional to the difference in the great circle distances between an epicentre and the point of observation have not been observed, tend to strengthen this same view.

Rules connected with the transmission of preliminary tremors which apparently promise to throw new light on the physical condition of the interior of the earth are—

(1) The velocity in kilometres per second with which these movements are propagated is equal to one-quarter of the square root of the mean depth of the chord or path (in kilometres) along which we may suppose they travelled.

(2) The duration of preliminary tremors, or the interval of time expressed in minutes by which they outrace the longer period waves (as shown on a seismogram), equals the square root of the mean depth of the supposed wave path expressed in kilometres.

These rules, taken in conjunction with a map showing the surface configuration of the globe, enable an individual observer not only to locate an origin but also to determine the time at which an earthquake originated.

Inasmuch as a Committee of the British Association have lent their weight to the establishment of a number of horizontal pendulums at various observatories around the world, within the next few years it is likely that our present knowledge of the seismic breathings of the earth's crust will be placed on a more extended and accurate basis than that on which it at present rests; and, amongst other things, we shall have accumulated new facts bearing upon the effective rigidity of our planet, which is evidently greater than that usually assumed.

The practical outcome of this work is already many-sided. Observers at magnetic observatories, like those at Kew, Potsdam and Batavia, are now aware that greater or less disturbances in the uniformity of their records sometimes accompany unfelt earth waves. Because the earth waves do not always leave a record of their occurrence, whilst there are magnetographs of the Kew type, as, for example, at Greenwich, Falmouth and Stonyhurst, which, so far as I can learn, are but very rarely disturbed, we can not say with certainty that the movements of magnetometers are altogether the effect of mechanical disturbance. At about 5 a.m. on September 21, very marked movements were recorded by the magnetographs in Batavia, evidently the result of a movement recorded in the Isle of Wight (see Fig. 8). Because the preliminary tremors have a duration of forty-three minutes, the distance of their origin from the south of England is probably about 112°. This, together with the fact that on this date a "slight tremor" was felt along the coast of North Borneo, makes it tolerably certain that the origin of this convulsion was one or two hundred miles from that island. Strange to say, at 7 p.m. on the previous evening a disturbance, in all its main features identical with the one here illustrated, is also to be seen on the Isle of Wight seismograms, from which it may be inferred that we have the records of two earthquakes from the same origin.

Assuming this to be the case then, so far as we can judge from information received from Batavia, it was only the second of these unfelt motions that caused disturbances in the magnetographs at that place. Not only are magnetographs affected at the time when huge earth waves slowly move the areas on which they are situated, but in Japan similar instruments situated near to an earthquake centrum have been perturbed some days before the occurrence of a world-shaking shock. Then, again, there are the remarkable secular changes in declination and dip observed between 1880 and 1885, at several eastern stations, respecting which Captain E. W. Creak, F.R.S., gives the following notes:—

Bombay.—Until 1883–85 the needle was moving eastwards. It then stopped, since which it has been moving westwards at an increasing rate. In 1881 there was a sudden change in the dip, and the needle is now going down.

Hong Kong.—Until 1875 the needle was moving eastwards. Then there was a rest until 1880, when it turned westwards. The dip was upwards until about 1880, since which it has turned downwards.

Batavia.—Until 1884 the needle was moving eastwards, when it became stationary. It is now moving westwards. The dip was moderately upwards until 1881, but it has now greatly increased.

When it is remembered that these remarkable changes took place about the time of large earthquakes in Japan, as, for example, that which led to the inauguration of the Seismological Society in 1880, the Krakatoa eruption of 1883, and that the illustrations of more immediate possible connections between seismic and magnetic phenomena may be multiplied, we recognise that the seismic survey of the world may not only throw new light upon its physical condition, but also, perhaps, it may lead to inferences respecting gravitational rearrangements of external materials and internal magmas. The sites of these, at present, hypothetical hypogenic changes we should expect to find in districts where secular movements and superficial loading, due to sedimentation, are most pronounced. Because earthquakes are apparently the results of critical conditions in these processes, the records from horizontal pendulums tell us that the sites we search for are to be found submerged beneath deep water at or near the base of steeply sloping continental areas. The enormous size of the superficial displacements which accompany certain of these suboceanic changes is indicated by the creation of sea-waves, which have often agitated the whole of the Pacific for a period of one or two days; and if these rearrangements of material on the bed of an ocean are related to changes in the state of stress or accelerations in the movement of an internal *quasi* rigid matter influenced by continental load, we see in the operations which culminate as earthquakes, causes which should, at least, have a local magnetic influence.

Captain Creak, writing on "the general bearing of magnetic observations," in *Science Progress*, April 1896, says: "It may be remarked in passing that a remarkable alteration in the amount of secular change has been noticed in the declination and inclination at the following

observatories: Bombay, Batavia and Hong Kong, about the period of the eruption of Krakatoa in 1883. This may be only a coincidence, but may it not also point to the possibility that the changes below the surface of the earth which culminated in that mighty explosion, and may still be at work, have had and continues to have magnetic effects which are recorded by the needles at these observatories?" (See also "The Volcanoes of Japan," by J. Milne, *Trans. Seis. Soc.*, vol. ix. part 2, p. 178, 1886.)

The seismograms of unfelt earthquakes tell the student of dynamical geology that certain activities to which he devotes attention are more pronounced beneath the ocean than they are on land, whilst the location of the origins from which these movements proceed indicate to the cable engineer districts to be avoided.

If we except the action of waves, the borings of teredo, and other influences resulting in cable destruction in shallow water, submarine earthquakes and their accompanying land-slides are responsible for very many interruptions of international communication. This form of destruction is particularly marked along the west coast of South America, and it is not unknown in the Atlantic, the Mediterranean, and the Indian Ocean. In 1888 a submarine earthquake cut off the Australian colonies from the outer world for a period of nineteen days, and the apprehension that the isolation was an act of war led to the calling out of military and naval reserves. Had Australia been provided with a single instrument to record the unfelt movements, which must have reached it, anxiety and expense would have been avoided.

From an official notification I learn that two West Indian cables gave way on December 31, 1897. I am not certain, but the Isle of Wight seismograms indicate that the failures probably took place at 11.30 a.m. G.M.T., on December 29.

One immediate use of a seismogram is that it tells us whenever a large earthquake occurs, and gives a locus for its origin, which information has already on more than one occasion been the means of correcting, confirming, extending and disproving ordinary telegraphic information. Sometimes messages have reached us which have contained errors in their dates of one or two days, others have been grossly exaggerated accounts of small disturbances, whilst a third group, inasmuch as they create feelings of anxiety without reason are the most reprehensible of all, have, if we except the feelings of satisfaction they gave to their senders, been without foundation. In all these instances the seismogram or its absence has assisted in the interpretation of the telegram.

Up to the present seismology has found foster-parents in the meteorologist and the geologist—the one collecting facts about earthquakes, whilst the other wrote about them. Because it has grown to unwieldy proportions, it seems time that the child should try and stand alone and become guardian of its own discoveries. In "diurnal waves" and "tremors" we see Romulus and Remus seeking a mother, and although they are not of the *genus terræmotus*, because they partially, at least, represent earth-movements, Seismology has become their guardian.

By a diurnal wave we mean a slow tilting which takes place in piers and buildings, especially on fine days, for six or ten hours rapidly in one direction, and during the remainder of the twenty-four hours, but more slowly, in an opposite direction (Fig. 9). This movement may be found underground where changes in temperature are insignificant. The actual causes of these movements are at present matters for speculation, but the theory which best explains the phenomena they present (as for example, that on opposite sides of a valley, it has been observed that movements take place simultaneously but in opposite direction), is that these changes in the vertical are due to differential changes on opposite sides of a station in the loads removed during the day, or acquired during the night by evaporation and condensation of aqueous vapours. During the day it is assumed that, by ordinary evaporation and the transpiration of plants, the bottom of a valley loses more weight than its comparatively drier and less clothed sides.

During a hot day the stream at the bottom of such a valley should discharge fewer and fewer gallons of water, whilst the valley bed, because it is relieved of load, should rise. For the remaining fourteen or eighteen hours, because aqueous vapour is condensed beneath the chilled surface of the ground, or as it emerges from the ground on plant and other surfaces, the stream in the bottom of the valley would increase its flow, and relatively to the sides and bounding ridges of the valley, where we may suppose the conditions for condensation to be less favourable, the lower parts of the same would become heavier and thereby sink. As to whether this concertina-like opening and shutting of valleys representing changes of slope of one or two inches in three or four miles in the average inclination of their boundaries really exists, all we can say is that instruments have given indications that can be explained on such a supposition. The fact that the piers carrying some of the instruments have risen from the chalk, and not from the alluvium, and that during long-continued wet weather there is continuous creeping of a horizontal pendulum towards the heavily loaded valley bottom, and that the

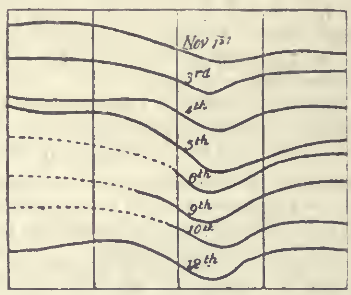


FIG. 9.—Diurnal waves at Shide, I.W., 1 mm. deflection = tilt 0″·5. (Milne.)

direction of greatest movement at the time of an earthquake appears to be at right angles to the dip, from which it may be inferred that valleys due to geotectonic folding exhibit a certain flexibility, tend to support the idea that the observed diurnal movements are due to actual movements of more or less extensive areas. No doubt some portion of the observed effects may be directly attributable to solar radiation.

In searching for an explanation of diurnal, annual and other changes in the vertical, the seismologist has had to consult the records of the astronomer, the observations of the hydraulic engineer, the botanist, and the farmer, and to experiment and search for information in domains far removed from anything supposed to be connected with movements of the ground.

Have changes in the vertical been most pronounced in regions where it may be supposed that orogenic changes are yet in progress? How far are changes in the vertical effected by seasonal and daily changes in temperature, by fluctuations in barometrical pressure, by the rise and fall of tide upon a coast line, and by lunar attraction? What tilting effects would result if the seasonal growth and partial removal of foliage and herbage on one side of an observing station were greater than those upon the opposite side? What is the rate at which alluvium may creep down the face of steep slopes, carrying with it perhaps a forest, and what is its cause? What is the amount of moisture transpired by various plants per day, per month, and per season? Do not some plants and

trees absorb rather than transpire moisture from the atmosphere at certain seasons? What is the transpiration of plants at night as compared with that during the day? Is there such a thing as subsurface dew, and what is its amount? What is the function of stones in arable land as fertilisers? What do we know respecting the diurnal flow in rivers, and the semi-diurnal rise and fall in certain wells? Will a squad of men walking up to the walls of an observatory, or the load equal to the weight of an average man at the base of a pier in the same produce any appreciable change of level on the top of such a pier? Are high mountains measurably deflected by wind pressure? In the workings of a mine beneath the sea what data do we possess respecting deflections in the roof due to the rise and fall of a superincumbent tide? What is the natural period of vibration of a chimney or building of given structure?

These are examples of the varied questions which have been placed before the seismologist, and to most of which, as the result of experiment and observation, he is able to give fairly definite replies. Although in a few instances these replies may not have given the assistance to his investigations expected, a consolation remains that

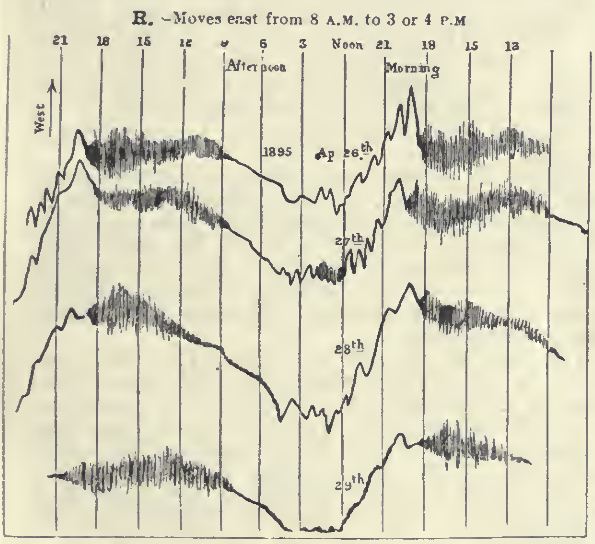


FIG. 10.—Irregular diurnal waves in Japan, always showing tremors from 9 p.m. to 6 a.m. (Milne.)

they have been of considerable value to workers in other fields.

Perhaps the greatest trouble against which the working seismologist has had to fight have been the ubiquitous, so-called, "earth" tremors (see Fig. 10). Sometimes the apparatus will swing, and perform for hours or days various irregular, and sometimes marvellously regular back and forth movements, with the result that all traces of important phenomena have been eclipsed (Fig. 11). Not only do "tremors" affect finely constructed horizontal pendulums, but in all probability they affect magnetographs, the delicate balance of the assayer, and accelerate or retard the swing of pendulums. They are frequent in winter, at night, and whenever the observatory in which they are recorded is crossed by a steep barometric gradient. They are particularly noticeable with a frost and a falling thermometer. With a howling gale, and even during a typhoon, when buildings shake and shudder, they are as likely to be absent as present (Fig. 12).

Because a light horizontal pendulum is more disturbed than one that is heavy, and that we observe at one station tremors are marked, whilst they are only shown feebly, or are entirely absent at another station a few yards distant, it is evident that we are dealing with movements due to currents of air, rather than with movements due to tremors in the ground. Although we fully recognise, as stated at the commencement of this article, that there are microseismic movements in the earth, it is very doubtful whether in the thousands of observations carried out day and night, especially in the Italian peninsula, these movements have been differentiated from those which are the result of atmospheric

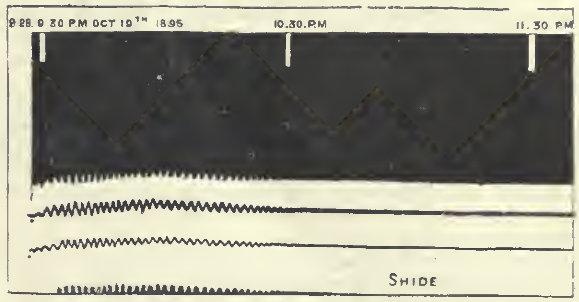


FIG. 11.—Pulsations or very regular tremors with periods of 2 or 3 minutes. The recording pendulum has always a natural period of about 15 seconds. (Milne.)

circulation. Simply opening or closing the door of a case covering an instrument will sometimes start or stop a so-called tremor storm. The fact that placing a tray of calcium chloride inside one of these cases will cause very large and continuous movements which cease on its withdrawal, indicates that air currents are partly due to the manner in which an atmosphere becomes dry or moist. In the search for the originating cause of tremors

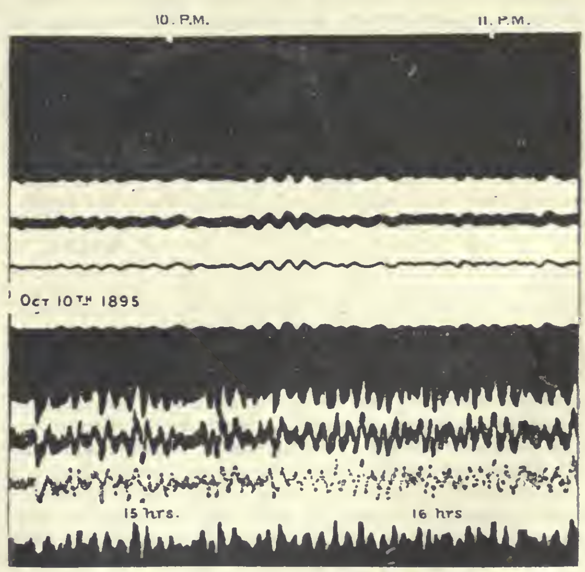


FIG. 12.—Commencement of a tremor storm at 10 p.m. with movements having a period of several minutes. At 15 and 16 hours they are very irregular, whilst later the band is blackened by these movements. (Milne.)

which has extended over a period of nearly thirty years, we see an excellent example of long-continued and patient work which, so far as the advancement of seismology is concerned, appears at first sight to have terminated in a fiasco. Now, however, we know that we have to distinguish between movements caused by the atmosphere and those coming from the earth. We see a reason why at particular observatories magnetographs are sometimes on the swing. The reason why,

under certain conditions, the assayer's balance may sometimes oscillate and quickly change its zero is understood. Possibly these air currents may indirectly have led to the abandonment of the Cavendish experiment at Cambridge, and explain why a very well-constructed horizontal pendulum is never quite at rest.

One very important piece of knowledge for the seismologist lies in the fact that these so-called tremors can be stopped by using covering cases through which air can circulate, but above all by working in a room that is almost draughty with ventilation. Sometimes a room will be found which it seems impossible to cure, whilst in the adjoining one, for reasons not quite clear, the same instrument will always remain at rest.

It seems as if there existed in rooms which may be fairly similar in appearance slight physical differences of the walls, the floors and ceilings, as, for example, with regard to dampness; so that in one room, in consequence of differences of temperature, power of desiccation and other properties between the different boundaries, we may have a slow circulation of air established which is inappreciable in an adjoining room. Whether this is the true explanation of the seismic bogey remains for more careful demonstration, but already the writer has learned that with draughty surroundings an instrument will remain at rest, whilst when this condition is neglected, what is apparently a slow and steady circulation of the atmosphere will cause motion. We yet wish to know why these troublesome visitors appear with such regularity at certain hours and seasons (see Fig. 9). One result of what we have learned is that now hundreds of feet of bromide paper have been saved from blackening, and unfelt earthquakes, which otherwise would have been eclipsed, have been clearly recorded.

In the above few notes all that is attempted is to give a scanty outline of the more important branches of work which at present attract the attention of the working seismologist. Other investigations which it is desirable to make relate to the irregular changes in level which are completed in a few minutes or several days, and above all those grander movements, the results of which are exhibited on the surface of our earth in the formation of continental domes and mountain ranges, together with those activities hidden from our view, which have been referred to as processes of secular flow and crush—in all of which we see the parentage of the earthquake.

J. MILNE.

THE CAMBRIDGE EXPEDITION TO TORRES STRAITS AND BORNEO.

DURING the preparation of a monograph on the anthropology of the Torres Straits islanders, I found the notes I had previously made were unsatisfactory on so many points that I decided to go out again in order to render them as complete as possible, though probably a great deal is by this time irretrievably lost.

A Committee of prominent members of the University of Cambridge is co-operating with me, and part of the cost of the expedition will be defrayed by a grant from the Worts' Fund, which is administered by the University.

The expedition will be almost entirely anthropological in character, but the land flora and fauna will not be neglected, and certain geographical observations will also be made.

The other members of the expedition are Dr. W. McDougall, Fellow of St. John's College, Cambridge, and of St. Thomas's Hospital, London; Dr. C. S. Myers, Caius College, Cambridge, and St. Bartholomew's Hospital, London; Mr. S. H. Ray, Dr. W. H. R. Rivers, St. John's College, Cambridge, Lecturer on Experimental Psychology at Cambridge and at University College, London; Dr. C. G. Seligmann, of St. Thomas's Hospital; and Mr. A. Wilkin, of King's College, Cambridge.

The work of the expedition will be distributed as follows:—I shall be responsible for the observations on the physical characters of the natives; their language and phonology will be studied by Mr. Ray. Mr. Ray, who has a world-wide reputation as an authority on the languages of Oceania generally, has already made a very careful study of the languages of Torres Straits ("A Study of the Languages of Torres Straits, with Vocabularies and Grammatical Notes," *Proc. Roy. Irish Acad.* (3), ii., 1893, p. 463; iv., 1897, p. 119). Drs. Rivers, McDougall and Myers will initiate a new departure in practical anthropology by studying comparative experimental psychology in the field. They will test the senses and sensibility of the natives as far as it will be possible under the local conditions, and make whatever observations they can on the mental processes of the natives. Dr. Myers will also pay especial attention to native music, and I shall continue my researches on the decorative art of British New Guinea.

The hygienic and medical aspects of anthropology will be studied by the four qualified medical men. The sociology of the natives, including such subjects as relationships, ownership, land tenure, descent of property, and the like, will be investigated by Mr. Wilkin. All the old legends that can be collected will be recorded, and an endeavour will be made to recover the old beliefs of the people. Other departments of anthropology will also be studied. Dr. Seligmann will act as naturalist to the expedition; one of his duties will be to identify all the animals and plants which are utilised by the natives in any way.

Besides the ordinary instruments for anthropometry, there will be a small, carefully selected, collection of apparatus for experimental psychology. Two mechanical phonographs will be taken to record the native songs, music and languages. There will also be a complete photographic equipment, including a cinematograph for reproducing native dances, ceremonies, and certain characteristic actions.

The main object of the expedition is to continue and, as far as practicable, complete the earlier observations made in Torres Straits; but, for the sake of comparison, it is hoped that observations will be made on Australians, Papuans, Melanesians and Polynesians, as opportunities present themselves. After spending a few months in the Straits a short visit will be paid to the mainland of New Guinea, in order to trace the relationship of the islanders.

Some of the party will then have to return home; but the remainder have accepted a very generous and enthusiastic invitation to visit Mr. C. Hose, the Chief Magistrate of the Baram District of the Raj of Sarawak. Mr. Hose, who is a Cambridge man (Jesus College), is a keen naturalist and has a very wide knowledge of the natives and their languages, and has a warm sympathy for the people themselves; consequently the expedition will have exceptional facilities for seeing something of the inland tribes of Borneo, and interesting comparisons may be expected between the different races which the expedition will have under observation.

The expedition will start about March 2, and will return early in the summer of 1899.

Any suggestions as to lines of investigation or methods of study will be gladly welcomed. If the curator of any museum or collection desires information respecting ethnographical objects from Torres Straits or British New Guinea, and sends sketches or photographs of such objects to me (Inisfail, Hills Road, Cambridge; or Thursday Island, Torres Straits, Queensland), I will take the illustrations with me, and will endeavour to obtain the required information at the spot where the objects were obtained. I shall also be pleased to make, as far as I am able, any special inquiries that any ethnologist may require.

ALFRED C. HADDON.

MINE ACCIDENTS IN 1897.

WITH commendable celerity the Home Office has issued, in the form of an advance proof, the tables of accidents and deaths at the Mines and Quarries of the United Kingdom last year. Six foolscap pages closely printed with figures are not likely to attract the ordinary reader; but if they are carefully scanned, several important facts come to light. The Diamond Jubilee year is remarkable for its small death-roll from explosions of fire-damp, as there were but twelve fatal accidents and only nineteen deaths. Probably such a happy result has not been known this century; at all events since 1851, when official statistics first began to be kept, the number of explosions has been gradually diminishing in the most satisfactory manner, and though several great disasters, each involving a loss of more than a hundred lives, have happened of late years, the total number of deaths from explosions has decreased, in spite of the enormous rise in the output of coal. According to the official statistics, the annual number of victims by explosions of fire-damp and coal-dust for the last forty-seven years has only in seven cases been fewer than 100, and in no case less than 49 until last year. Far less satisfactory is the death-roll from falls of ground; this shows no signs of diminution; on the contrary, we find 485 deaths against 439 in the previous year. How long is this state of things to continue? Why do falls happen? The reply is "From want of supports," and the self-evident remedy which suggests itself is "systematic timbering." The German Government has taken the matter in hand by appointing a special Commission to report upon means of preventing accidents from falls of ground. Are we to wait until this Report is issued before grappling with the question? The dangers of fire-damp and coal-dust have now been dealt with by Statutes; and the worst death-trap in the mine should also receive in its turn some special legislative attention?

Shaft accidents are diminishing in number in a way that makes the shaft nowadays almost the safest place in the mine. The miscellaneous accidents, most of which are put down to haulage, are still numerous. It is curious to note, while dealing with fatalities from miscellaneous causes, that the worst mining disaster in the British Isles last year happened at a lead mine and not at a colliery, for an underground fire claimed twenty victims. On the whole, there were 972 persons killed by accidents at mines in this country last year, compared with 1065 in 1896. This is a decrease of ninety-three deaths. How far this is a real improvement cannot be stated until the statistics of persons employed have been collected, so as to enable the death-rate to be calculated.

The final tables tell us that 123 persons were killed at the quarries of the United Kingdom which are included by the Quarries Act, from being more than 20 feet deep. There is a decrease of one death compared with 1896.

The statistical matter has been set up this year in an improved and far more convenient fashion, for the figures can now be read without twisting round the pages sideways.

THE PROPOSED MIDLAND UNIVERSITY.

EDUCATIONAL authorities throughout the country cannot but rejoice in the important speech which Mr. Chamberlain made in Birmingham on Thursday last. A recent Act of Parliament has been passed whereby the Mason College has been made a University College, governed by a representative court of governors, and it was in his new capacity of President of the Mason University College that Mr. Chamberlain took the opportunity of formally launching the scheme for the creation of a great University of the Midlands. The idea of a Midland University has been under consideration for several years past, and with the strong support now promised by Mr. Chamberlain, Birmingham may confidently look forward to shortly becoming the proud possessor of what London has been struggling in vain so many years to obtain—a great teaching University depending for its position and authority not on traditions, but founded in harmony with modern requirements, in sympathy with the scientific and educational needs and aspirations of the day.

Prof. Mahaffy, a few weeks ago, humorously represented some of the objections which have been raised to the establishment of a new University in Birmingham by remarking, "Oxford I know, Cambridge I know; but who are ye?" Mr. Chamberlain, however, has met and anticipated such and similar flimsy protests by at once, in his characteristic manner, going to the root of the matter. "The new University cannot in any sense be a competitor with the old Universities of Oxford and Cambridge . . . they offered associations, traditions, and conditions which it could not, under any circumstances, attempt or hope to emulate. Therefore, whilst they could not imitate Oxford and Cambridge if they would, he would say also that they *would not if they could* . . . because when they came to create new Universities in this modern time, and under modern conditions, it was something rather different they had in view." It cannot be sufficiently recognised that whilst traditions may be, and often are, a power for good, a slavish and blind adherence to them may also work incalculable mischief in society. It is not too much to say that the great University Colleges which have grown up in all parts of the country during the latter half of the present century, have been not a little hampered in their work, not a little shorn of the recognition due to them by being, in some respects, overshadowed by the older Universities. The splendid scientific work, however, which has emanated from these too frequently derided and belittled Provincial Colleges is gradually bringing about a change in public opinion. The munificent support which has recently been accorded to the Owens College, Manchester, and the attitude which so distinguished a statesman as Mr. Chamberlain has taken up with regard to the proposed Midland University, are auguries that a new era is commencing, when the public are beginning to realise what has been and still remains to be done by modern Universities unhampered by local traditions, in touch with the time, and animated with enthusiasm not only for the communication of knowledge, but for the advancement of learning by the prosecution of original researches. There is one point to which we venture to hope those entrusted with the great task of building up this new University will give due weight, and that is the study of modern languages. We as a nation are far behind Germany, for example, in the importance which we attach to the acquirement of foreign tongues, and our trade, we have often been told, suffers in consequence. Let Birmingham set the example, and in addition to thoroughly equipping its faculties of science, art and medicine, let it have the honour of establishing a great school of modern languages. Educationists in this country, who for years have been vainly endeavouring to obtain an effectual hearing for the need of harmonising modern scientific education not only with the requirements of the time, but with the advance in science, owe Mr. Chamberlain a debt of gratitude for his address, of which we give the following abstract from the *Times* report:—

The new governing body of the College were entertained at luncheon in the Council-house by the Lord Mayor (Mr. C. G. Beale), who proposed the toast of "Mason University College," which was coupled with the name of the president, Mr. Chamberlain.

Mr. Chamberlain, in reply, said that day's proceedings marked a stage in the history of the College. He did not dwell upon the service rendered by the College to the city and

district, its rapid growth, and the reputation it had acquired, which was due in large part to the capacity and the character of the teachers it had been able to attract. The Mason College at the present time was hampered by a lack of resources. They had not the funds to deal with the growing requirements of the time and of the district, to provide proper appliances, proper buildings, and proper remuneration for those who acted as professors and demonstrators in the institution. The Lord Mayor had been good enough to say that the deficit was a moderate one, but deficits had a most uncomfortable habit of increasing, and, although the endowment which was provided for the College by the munificence of Sir Josiah Mason was sufficient for it in its infancy, it was inadequate for present requirements. The trustees had always contemplated the possibility that they would be able to crown the edifice of their educational institution by the establishment of a local University to meet the requirements of the district, and he need hardly point out that if that object found favour in their eyes, as the greater included the less, so the relief desired would come in the creation of a properly-endowed University into which the Mason College would be practically absorbed. He hoped the ambition to which he had referred would not in the present day be considered unreasonable.

The Multiplication of Universities.

There was a time, no doubt, when members of the older Universities, and men who were altogether independent of them, believed that the multiplication of Universities would injure education; that it would lead, in a certain sense, to the degradation and the lowering of the value of the degrees which Universities conferred; but very much had happened in the last twenty years, and he could hardly imagine any reasonable man arguing in that strain at the present moment. The fact was the need of the local University had been recognised, and at the present time Birmingham, and the surrounding district, was the only great centre in England which was not already provided with such an educational institution. Liverpool, Manchester, and Leeds had their Victoria University; Newcastle was closely connected with Durham; Wales had its own University; London had a University of a kind, which, when Londoners were able to make up their minds, would no doubt develop into something much better. He could not conceive of any district at the present time which more needed or more deserved the establishment of such an institution than the district in which he was speaking. But if they went outside England the argument was greatly strengthened. They looked to Germany for an example and a model of everything in the way of educational organisation and progress. Education was made in Germany, and they were not ashamed to take the lesson to heart. Germany, with forty-six millions of people, had twenty-one Universities. Their own sister kingdom, Scotland, with four million people, had four Universities; in England and Wales, with nearly thirty millions of people, they had six Universities. *A priori*, at any rate, he thought they had made out a case for a University.

Education in the Midlands.

But there were other reasons he drew from the educational history of the district. The right hon. gentleman then proceeded to sketch the rapid and remarkable development of education in the district, speaking in high terms of the educational institutions. They had Mason College, which at last had been incorporated as a full University college. Was it not clear that after that which had been accomplished so rapidly they might ask without presumption for an institution which should crown that circle of their educational opportunities, and which should direct and control and guide and coordinate these local educational works, and so put themselves in a position to equal and rival every other part of the kingdom? He would like to strengthen his argument by a quotation from a man who, perhaps more than any other, was qualified to speak upon that subject—he meant the late Prof. Huxley, who said: "But a city University is, in my judgment, a corporation which has charge of the interests of knowledge as such, and the business of which is to represent knowledge by the acquirement by its members of increased knowledge, by their investigations to diffuse knowledge, by their teaching, and last, but not least, to create a respect for knowledge among their fellow men by their personal example and influence." Prof. Huxley was writing then in reference to the proposed creation of a University for Manchester. Whatever argument was then applicable to Manchester was applicable in no less a degree to Birmingham and the district, because he believed that there was no district in the kingdom that was so distinct in what he might call the peculiar genus, knowledge, and character of its people, and in the nature of its occupations as that great manufacturing district which had the vast population of more than 2,000,000 or so in and around Birmingham within a radius of twenty or thirty miles.

The Objects of the University.

What did they mean by a University? What new institution was it they desired to place in Birmingham? They meant, he took it, a great school of universal instruction not confined to any particular branch of knowledge, but taking all knowledge as its province, and arranging regular courses of complete instruction in all the great branches of information. They must, in the second place, use that knowledge so that the professors and teachers should be associated with the students, and all should be students together, and so that those who came to teach should continue to learn, and so that the most important work of original research should be continuously carried on under the most favourable circumstances; and, lastly, they meant by a University a body which should have power to control the courses of education and to confer degrees which should test the value of its instruction. He put that last because he believed that of the three objects of the University it was the least important, although it was necessary to a University, and without it Mason College had lost a number of students. One thing he might at once admit. Any new University which they might succeed in establishing would not be in any sense a competitor with the old Universities of Oxford and Cambridge. Those Universities appealed necessarily to classes many of whom they could not expect to touch, and they offered associations, traditions, and conditions which they could not under any circumstances attempt or hope to emulate. Therefore, while they could not imitate Oxford and Cambridge if they would, he would say also that they would not if they could, because, while the older Universities supplied a want of their own, and if anything were to happen to them they would leave an incalculable gap in all that was interesting and picturesque in English life and English history, yet when they came to create new Universities in this modern time and under modern conditions it was something rather different that they had in view. He would say, rather, that they should take as their model, not indeed absolutely, the great Universities of Scotland—of Edinburgh or of Glasgow. He thought the University of Glasgow was built, much as they hoped theirs would be, upon a pre-existent college which had subsequently been absorbed or developed into a University. But there was no doubt whatever, from the experience of such Universities as those he had referred to, that to place them in the middle of a great industrial and manufacturing population was to do something to elevate the whole mass to higher aims and higher intellectual ambitions than would otherwise be possible to people engaged entirely in trading and commercial pursuits.

The Need of Money.

Rome was not built in a day, and their University would, he dare say, for generations yet to come give opportunities to liberal benefactors to improve and extend it. But one thing was essential, one thing they must do—put the University in a position to attract the best teachers, to attract men of the highest reputation, and to keep them there when they had induced them to come. Pointing out how this ideal could be attained, Mr. Chamberlain remarked that all they wanted was very little—only money; and that, he hoped, would be forthcoming. The sacrifice must be proportioned to the importance of the object they had in view. He had no idea that Birmingham or the district would be satisfied with a starved University. He would rather wait another fifty years if necessary than start with everything pinched and mean about them, with insufficient buildings, with inadequate appliances, and, above all, with insufficient remuneration for those whom they employed. Therefore, he urged that they should start the scheme with a determination to make it a great success. Let them start it with an endowment which, at all events, would secure the main objects which they had in view. It was calculated that what would be required would be 250,000*l*. He was not at all inclined to minimise a demand of that sort made under the circumstances. Money would not be spent in colossal buildings. They must come later on. It was chiefly to secure

a satisfactory endowment for a complete professorial body in connection with the University. In addition to the chairs which were already endowed they wanted endowments varying from 400*l*. to 600*l*. a year, which he did not think would be considered by any one as excessive, for fifteen chairs. The cost of such an endowment was, therefore, from 12,000*l*. to 20,000*l*. If this work was to be carried on they must not expect too much from individuals. They might expect something from the great trade of Birmingham, a little from each member of the trade, if they would organise themselves for the purpose. The great industries when appealed to would see that they had a great duty in that matter, and would be glad to be represented in the work. They had already made some progress, and from two or three whom they had approached they might certainly expect the endowment of such a professorship. His duty that day was to put the question before them and ask them to accept the principle and give their good will and assistance in carrying it out.

FRANCESCO BRIOSCHI

BIOGRAPHICAL notices of this veteran Italian mathematician, who died on December 13 last, have been given in the *Comptes rendus* by M. Hermite, and by Cremona and Beltrami in the *Annali di Matematica*, the journal of which Brioschi was chief editor, and one of the founders in 1858; from these notices many of the following details of Brioschi's scientific work have been extracted.

This work covers about half a century in time of production, and ranges over the subjects of Analysis, Geometry, Higher Algebra, Differential Equations, Elliptic and Abelian Functions, Mechanics and Mathematical Physics.

Brioschi occupied himself at first with various dynamical questions, in continuation of the researches of Lagrange and Dirichlet. He next turned to the development of Gauss's analytic theory of surfaces, which had hitherto not attracted the attention it deserved. He also discussed the theory of the Correspondence of Poncelet's Polygons; as subsequently developed by Moutard and Halphen, this theory appears likely to provide the simplest analytical view of the Multiplication and Division of Elliptic Functions, at present engaging the attention of Prof. H. Weber.

But the true bent of Brioschi's genius was found when he attacked the general theory of algebraical equations, being inspired by Hermite's discovery of the transcendental solution of the quintic equation, which has recently been summarised with developments in Klein's Lectures on the "Ikosahedron."

The history of the quintic equation throws a curious light upon the ways of a certain typical British school of mathematicians, who are accustomed to jog along in intellectual isolation, knowing and caring nothing for the advances made by others; like "Rip van Winkles," as Clifford called them.

Working in this hermit-like way, Mr. Jerrard made the important discovery that it was possible by the solution of algebraical equations of an order not higher than the third, to reduce the general quintic equation to the trinomial form; but Klein has pointed out, in the "Ikosahedron," that all this had been done a hundred years ago, by the Swedish mathematician Bring, in 1786.

Arguing by analogy, Mr. Jerrard, it is related, was firmly convinced that by the solution of a quartic, it would be possible to reduce the quintic to the binomial form, when the algebraical solution would be complete; and he died in happiness before having discovered his error, which a slight acquaintance with the work of Abel and Galois would have revealed.

The reduction by Hermite of the general quintic equation to the form of the Modular Equation of the Transformation of the Fifth Order of Elliptic Functions suggested to Brioschi the examination of the corresponding equations of higher order; and Brioschi's last communication was one to the Mathematical Congress at Zürich, 1897, on the particular case of the Transformation of the Eleventh Order.

Galois's statements ("Les idées précipitamment émises," Halphen, "Fonctions elliptiques," iii. p. 124), which he did not live to demonstrate, that the Modular Equations of the Fifth, Seventh, and Eleventh Order have Resolvents of the same order, had long baffled analysts, and they did not receive universal acceptance till the appearance of the article in "Tortolini," 1853, by Betti, Brioschi's co-editor, who succeeded in retracing Galois's line of argument; Betti's article being followed up by Hermite, in the *Comptes rendus*, 1859.

In his biographical memoir M. Hermite points out that Brioschi was the pioneer in another line of generalisation in the theory of algebraical equations, in his discovery of the solution of the general sextic equation, employing for that purpose the six even Θ functions, of two variables. The details of the development of this theory will afford plenty of employment to young mathematicians for some time to come.

In addition to his scientific labours, Brioschi found time to devote to public duties; he acted as an Under-Secretary of State, and was a Senator of the Upper House of the Italian Parliament; he was an organiser of the railway system of Italy, and he served on the International Committee of the Metric System.

He was a member of most of the Academies and Scientific Societies of Europe and America, and President of the Royal Academy of Lincei. The biographical notices by those who were personally acquainted with him speak highly of the respect and esteem which he inspired.

G.

REV. C. L. DODGSON.

A FORMIDABLE champion of Euclidean methods in the elementary teaching of geometry has just passed away after a short illness. The Rev. Charles Lutwidge Dodgson was born in 1832 at Daresbury in Cheshire; and, after passing five years at Rugby School, matriculated in 1850 at Christ Church, Oxford, where he was appointed a student in 1852, and graduated in 1854 with honours in both classics and mathematics. He was appointed Mathematical Lecturer in the College in 1855, and retained that office till 1881; he further served the University as Mathematical Examiner in 1863, and Moderator in 1868.

The mathematical subject in which he was most interested was the elementary teaching of geometry; of this he had a personal experience of twenty-six years. Without stint of labour he submitted to rigid logical analysis every text-book on the subject that came to his notice, undismayed by their surprising number, the result being the amusing and, at the same time, deep "Euclid and his Modern Rivals," published in 1879, in which he demonstrated the logical superiority of Euclid's method over all the others examined. The Appendices of this book are very valuable. A "Supplement" to it appeared in 1885. In 1882 he edited Euclid, Books I. and II., with an introduction; and in 1888 he published "A New Theory of Parallels," in the third edition of which (1890) he simplified his fundamental axiom.

His other mathematical work comprises "A Syllabus of Plane Analytical Geometry" (1860), "Formulæ of Plain Trigonometry" (1861), "An Elementary Treatise on Determinants" (1867), "Euclid, Book V., proved Algebraically" (1874), and "Pillow Problems" (1893). He invented a new method of evaluating determinants, which is published in the *Proceedings* of the Royal Society for 1866, and also a method (which was published in NATURE) of easily determining the day of the

week corresponding to any date. In October last he described in NATURE a brief method of dividing a given number by 9 or 11; and a second paper on the same subject, which appears in our correspondence columns this week, probably represents his latest contribution to mathematics.

A characteristic of all his work was the absolute exactness of expression at which he aimed, so that his definitions and proofs should be logically perfect. This carried a certain severity into his work, since, as he has himself remarked, a semi-colloquial style is apt to be also semi-logical, as nothing is more easy than to forget, in an argument which is interwoven with illustrative matter, what has, and what has not, been proved. It further tended to require the repetition of what might for exactness have to be a somewhat cumbrous periphrasis, to prevent which, therefore, he introduced a number of new terms and symbols; few of these have, however, been adopted into general use, though of the latter some are extremely expressive, and in his hands were of great value.

Mr. Dodgson's mind was essentially logical, in spite of the whimsical humour which has endeared "Lewis Carroll" to every boy and girl—nay, every adult—in the kingdom; and of late years he devoted a large part of his time to the study of the syllogistic methods of formal logic. In 1887 he published "The Game of Logic," and in 1896 "Symbolic Logic, Part I."

A shy and retiring man, he was to his friends a most charming companion, overflowing with the quaintest of humour, and one whose love for children was typical of himself, and whom to know was to love.

NOTES.

MATHEMATICIANS of all countries will be glad to hear that active steps are being taken to perpetuate the memory of the late Prof. J. J. Sylvester in a manner worthy of his reputation and in consonance with the spirit of his work. The movement was originated in this country by a few friends and admirers of the late Professor's, who decided upon founding a Sylvester Medal for the encouragement of mathematical research. The sympathy with the movement displayed by all the mathematicians who were communicated with, led the initiators to the conclusion that the most appropriate memorial would be one of international foundation, the more especially as Sylvester had a large number of friends and pupils in America, where indeed he may be said to have brought about a mathematical awakening through his connection with the Johns Hopkins University. The list of the International Committee which has now been issued, although only a preliminary one, comprises nearly the whole of the leading mathematicians of the world, besides many of the personal friends of the deceased mathematician and the representatives of the Universities of Oxford, Cambridge, London, Glasgow, Edinburgh and Dublin. From this list it might appear invidious to select names, but it is satisfactory to be able to call attention to the fact that it includes the Chancellor, High Steward and Counsel of the University of Cambridge, the Vice-Chancellor of the University of Oxford, the Provost of Trinity College, Dublin, the President of University College, London; with Lord Kelvin and Prof. P. G. Tait as representatives of the Universities of Glasgow and Edinburgh, and Prof. Henrici of the City and Guilds Institute. France is represented by Profs. Hermite, Poincaré, Camille Jordan, and Darboux; Germany by Profs. Schwarz, Klein, Fuchs, Gordan, and Lindemann; Italy by the late Prof. Brioschi, and by Prof. Cremona; and Sweden by Prof. Mittag-Leffler. America has no less than fifteen names on the list, among them being President Gilman of the Johns Hopkins, Profs. Simon Newcomb, Willard Gibbs, and others representing the mathematical chairs of the various Universities. It is indeed certain that some movement of the kind would have been initiated in America if Sylvester's admirers in this country had not taken action. Now through Dr. Cyrus Adler, of the Smithsonian Institution, and Dr. G. Bruce Halsted, of Texas (a former pupil of Sylvester's), the Americans are working for the general scheme, and the two gentlemen named are acting as Treasurers for the United States. The general Treasurer of the fund is Lord Rothschild; Major P. A. MacMahon is acting as Hon Secretary, and Prof. Meldola, as a friend of the late Prof. Sylvester's, undertook the arduous work of preliminary organisation with the results which we are now making public. The executive Committee consists of Lord Rothschild, Major MacMahon, Prof. Forsyth, Prof. Greenhill, Prof. Henrici, and Prof. Meldola as Organising Secretary. We are informed that the subscriptions from private sources reached over 500*l*. at the end of the year, and now exceed 600*l*., the American contributions not having yet been forwarded. It is proposed that the Medal shall be awarded triennially through the Council of the Royal Society, irrespective of nationality. Any friends of Sylvester's, or others who desire to participate in the movement, may send contributions to Lord Rothschild, New Court, St. Swithin's Lane, E.C.

MRS. TYNDALL, the widow of Prof. Tyndall, has sent the following letter to Sir James Crichton-Browne, F.R.S., the Treasurer of the Royal Institution: "Dear Sir James,—As an expression of his attachment to the Institution, with which he was so long connected, and of his sympathy with its objects, my dear husband desired me (at such time as should be most convenient to myself) to present in his name to the Royal Institution 1000*l*. to be disposed of as the Board of Managers may see fit for the promotion of science. I have now the pleasure of remitting to you this sum. Yours faithfully, LOUISA C. TYNDALL." Sir James Crichton-Browne, in the course of his letter acknowledging this generous donation, remarks:—"The managers would, I am sure, desire to be guided by any wish of yours as to the application of the gift; but, in the absence of any explicit directions, they will, I have no doubt, employ it in the promotion of that original scientific research in which your husband's vivid and penetrating intellect delighted to exercise itself. Revered as your late husband's memory is, and ever must be, in the Royal Institution, this posthumous mark of his solicitude for its welfare will, if possible, deepen the affectionate esteem in which he is held."

THE Council of the Royal Astronomical Society have awarded the Gold Medal of the Society for this year to Mr. W. F. Denning, "for his meteoric observations, his cometary discoveries, and other astronomical work." The award was confirmed on Friday last, and the medal will be given at the annual general meeting next month.

THE deaths are announced of Dr. Eduard Lindemann, scientific secretary in the observatory of Pulkova; and Dr. Oscar Stumpe, well known for his contributions on the motion of the solar system.

DR. MAQUENNE, assistant at the Paris Muséum d'histoire naturelle, has been nominated professor of plant physiology, in succession to the late M. Georges Ville.

AT the February meeting of the Edinburgh Mathematical Society, a discussion on the proposal that, in the teaching of elementary geometry, Euclid's definition of proportion be abandoned, will be introduced by Prof. Gibson.

WE regret to see the announcement of the death of Lieut.-Colonel C. Cooper-King, lecturer in natural science at the Staff College, Camberley. Colonel Cooper-King was a Royal Marine Artillery officer, and before joining the Staff College was an instructor at the Royal Military College, Sandhurst.

A letter which appears in our correspondence columns, on poisoning from Koda millet, which is extensively used as a food-grain in times of scarcity, furnishes another instance of the urgent need that exists for further facilities for scientific investigation in India. Matters are continually arising which ought to be made the subjects of systematic inquiry, but at present the means for carrying out such investigations are altogether inadequate to the wants of our great Indian Empire.

We learn from *Science* that ground was formally broken for the Museum Building of the New York Botanical Garden on December 31. The construction and equipment of the building will cost 347,019 dollars. The plans for the great range of horticultural houses have been completed, and specifications for them have been printed. The sum of 15,000 dollars, in addition to the funds provided by the Act of Incorporation, has been made available for the building of portions of the drive-way system. During the past season about 2900 species of plants have been obtained, together with large quantities of museum, library, and herbarium material.

The Royal Photographic Society is organising an international exhibition of photographic apparatus and photographs, which will open at the Crystal Palace on April 27. In addition to the usual displays of pictures, &c., the leading firms, manufacturers and dealers, will be largely represented. There will also be extensive loan collections, illustrating not only the history of photography, but its scientific and commercial applications, photo-mechanical processes, photographs in colours, photographs by means of the X-rays, and kindred exhibits. The exhibition, the arrangements for which are in the hands of a joint committee of members of the Society and exhibitors, promises to be the largest and most interesting collection dealing with photography that has ever been got together.

The sixteenth annual meeting of the American Society of Naturalists and Affiliated Societies was held at Cornell University at the end of last year. In the absence of the president, Prof. Whitman, of the University of Chicago, the chair was taken at the opening meeting by Prof. S. F. Clarke. The officers elected for the ensuing year are :—President: H. P. Bowditch, Harvard Medical School. Vice-Presidents: Prof. Wm. James, Harvard University; Prof. Simeon H. Gage, Cornell University; Prof. H. S. Williams, Yale University. Secretary: Prof. H. C. Bumpus, Brown University. Treasurer: Prof. John B. Smith, Rutgers College. Executive Committee: Prof. J. P. McMurrich, University of Michigan; Prof. E. G. Conklin, University of Pennsylvania. At the instance of Prof. Morgan, of Bryn Mawr College, the Society voted one hundred dollars towards an additional table at the Naples Marine Biological Station, and fifty dollars for the Naturalists' Table at Woods Holl. It was reported that President McKinley was about to appoint a politician to the office of Fish Commissioner, and the sentiment of the assembled investigators upon this matter is shown in the following resolution presented by Prof. C. L. Bristol, of New York University, and supported by Prof. H. F. Osborn. "Resolved: (*a*) That the American Society of Naturalists as representatives of the principal scientific and educational interests of this country, unanimously express to the President and Congress of the United States their sentiments that the Commissioner of Fish and Fisheries should, according to the law of 1888, governing his appointment, be a person of proved scientific and practical acquaintance with the fish and fisheries of the coast. (*b*) That it is of the utmost importance that the Fish Commission, as one of the most useful scientific institutions of the Government, should be free from political influence and should be administered with the highest degree of scientific efficiency by an experienced officer." A discussion was held on the subject of "The Biological Problems of To-day," and it was dealt with from the points of view of palæontology, botany, anatomy, psychology, physiology, developmental mechanics, and morphogenesis. In addition to the combined meetings of the societies, the following bodies held separate meetings for the communication and discussion of papers bearing upon their particular branches of science: American Physiological Society, American Morphological Society, American Psychological Association, Association of American Anatomists, Association for Botanical Morphology and Physiology, Section of Anthropology of the American Association. The Society will meet next winter at New York.

In the *Zeitschrift für Vermessungswesen*, Prof. Hammer directs attention to a Babylonian plan depicted on a clay tablet found in the excavations at Tello, and now preserved in the Constantinople Museum. The plan was made about 3000 years before the Christian era, and represents an estate belonging to King Dungi. It is of importance not only as a contribution to the early history of surveying, but also as a confirmation of the views on Babylonian measures of length and of area propounded by Reisner at a meeting of the Berlin Academy of Sciences on April 9, 1896. A copy of the plan has been examined by Eisenlohr, the eminent authority on Egyptian archæology, and he claims to be able to read from the cuneiform inscription the names of the two surveyors engaged. On one side of the tablet there is a dimensioned sketch of the plan of the estate not drawn to scale. The estate is divided by the survey lines into rectangles, right-angled triangles, and trapeziums. In each case the area is stated, two results obtained by different methods being given. Eisenlohr has plotted the survey, and his calculations of the area agree with the results given on the tablet. On the other side of the tablet the areas of the various portions are added together, two sets of figures being used, and the arithmetical mean taken as the correct area. The unit adopted, the *gan*, is thought to be equal to 4199 square metres. The absolute measures are, however, of slight importance. More important is the fact that land surveying was carried on 4000 years B.C., apparently in an accurate manner, and certainly with check measurements.

M. E. Dubois (*Bulletins de la Société d'Anthropologie de Paris*, 1897, fascicule 4) infers from theoretical grounds, based partially upon observation of the proportion of the surface of the retina to that of the body, that the weight of the brain of mammalia of similar form and the same species, varies directly as the surface of the animal.

A fresh development of Dr. Folgheraiter's investigations on the magnetic properties of Etruscan vases is described in the *Rendiconti della R. Accademia dei Lincei*, vi. 12, the object of the present experiments being to discover by what process the black vases obtained their colour. Three hypotheses had been advanced by archæologists: the first, that the vases were made of a special kind of clay; the second, that the clay was mixed with fine carbon or lamp-black; and the third, that the colouring matter was introduced into the clay after the vases had been formed, and possibly after they had been baked. Dr. Folgheraiter found, however, that carbon mixed with clay disappeared almost completely when heated to a temperature of about 380°, and that fragments of the old vases also lost their colour at that temperature; while to account for the magnetic properties of the vases they must have been heated to over 420°. Moreover, the clays experimented on did not lose their plasticity until a temperature of 420° to 500° was reached. The first two hypotheses were thus negatived. With regard to the third, it was found that the blackening could not be effected by heating in a closed chamber full of carbon; moreover, if the carbon was infiltrated into the pores of the clay by carbonisation, it did not burn away till a higher temperature was obtained than was

sufficient to decolorise the vases. Thus neither of the three hypotheses was corroborated by experiment. Dr. Folgheraiter suggests as a possible explanation that the clay, after being baked, may have been soaked with bitumen, and then heated to 300°; it would thus acquire a polished black surface with the colour gradually fading towards the interior, as in these Etruscan vases.

THE "Illustrations of Maori Art," by Mr. H. Hamilton, now in course of publication by the New Zealand Institute, is the most attractive contribution to ethnography we have seen for a long time. The first part of the work, on the Canoes, was issued some months ago, and the second part, dealing with material relating to "Maori Habitations," has lately come to hand. The three succeeding parts will be devoted to weapons, dress and decoration, and social life. The present part contains twenty-three plates upon which are reproduced, by half-tone process, photographs of characteristic buildings of the New Zealanders, and ornamentations with which the framework and different parts of the habitations were embellished. The accompanying illustration, which reproduces one of the plates on a reduced scale, is a testimony to the ability of the Maoris as wood-carvers, and to the high quality of the pictorial part of Mr. Hamilton's work. The carvings here shown are ornaments for doorways, the three upper ones being in the South Auckland Museum, and the lower one in Mr. Hamilton's own collection. In addition to illustrations of this kind there are twenty-nine examples, in chromo-lithography, of Maori rafter patterns; diagrams of the construction of a Maori house; a valuable introduction on the habitations of the Maoris; and descriptive notes on the illustrations. The work is commendable both in plan and execution, and when it is completed we shall refer more fully to its scope and value.

Maori Carvings for Doorways.

A PHOTOGRAPHIC method of measuring the height of a balloon, and at the same time comparing the results with those furnished by barometric readings, is described in *La Nature* for January, by M. L. Cailletet. The apparatus consists of a camera with one lens pointing downwards, by means of which a photograph of the country below the balloon is taken; at the same time a lens at the top of the camera projects on the upper side of the sensitised film an image of the dial of an aneroid barometer placed above the apparatus. By measuring the distance between any two points on the photographic view, and comparing with a map of the district, the altitude of the balloon can be accurately found, and the law connecting it with the barometer reading verified experimentally.

THE Pilot Chart of the North Atlantic Ocean, issued for the present month by the Hydrographer of the United States, shows that some very severe weather was experienced during December. Many of the storm centres were in high latitudes, so that vessels along the Transatlantic routes met with north-westerly squalls of hurricane force, accompanied with snow and hail. The most severe storm of the month was one situated about latitude 54° N., longitude 44° W., on December 6, and which reached the neighbourhood of the Orkney Isles on the 8th and 9th. For some days the wind blew with hurricane force north of latitude 55° N., and east of longitude 20° W. It often happens, especially in the winter season, that in the vicinity of the Azores rough weather is experienced or several days at a time; and, with the view of illustrating the behaviour of these storms, a synoptic chart of one of them is given. They differ from the storms of other regions in that the barometric depression rarely attains any great depth, and that they follow an irregular course, the centre frequently recurving in a manner suggesting an effort to get to the eastward in the face of some resisting force, probably an area of high barometric pressure in the vicinity of the British Islands. Another feature of these storms is the suppression of the trade-winds, which is an important consideration for vessels bound from the Equator to the Channel.

DR. A. FRANZ contributes a long paper to the *Deutsche geographische Blätter*, on the possibility of establishing regular communication by sea between Europe and Western Siberia. The meteorological and hydrographical conditions are examined with as much detail as the somewhat scanty observations available admit; and the general result seems to show that the difficulties in the way of regular navigation are not insuperable, although sufficiently great to make it doubtful if it is worth

while, from a commercial point of view, to try to overcome them.

THE first part of a new volume of the *Memorie della Società Geografica Italiana*, recently issued, contains, besides other shorter papers, the results of an exhaustive research into the records of earthquakes in Italy during the period 1800 to 1872, by Signor M. Baratta. The author does not pretend to completeness, but his list is, as he says, a great advance on anything hitherto available. The arrangement is chronological, and under each date are given the places where the disturbance was recorded, the hour, the nature, direction, and intensity of the shock when possible, and finally the source of information.

THE *Mittheilungen du k.k. Geographischen Gesellschaft* of Vienna contain a note announcing satisfactory progress in the work of organising a meteorological service in the parts of the Balkan peninsula under Austrian rule. Discussion of the observations already made throws considerable light on the obscure transitional phases of climate occurring between the Mediterranean and continental regions.

WE have received the third volume—that for 1894—of the *Bibliotheca Geographica*, edited by Dr. Otto Baschin. The work has been carried out with the same completeness and accuracy as formerly. The only new feature is an extension of the number of Slavonic languages included. The experiment of giving titles of papers in Russian and Czech, with German translations appended, was tried for the first time last year, and has been so far successful that Polish and Croatian literature is now added.

THE Director of the Botanic Gardens at Buitenzorg, Java, has issued in English a Hand-guide to the Gardens, in a neat square size, accompanied by a plan.

WE have received from the Gebrüder Borntraeger of Berlin a daintily produced catalogue of their natural history publications, especially in botany and geology. The firm has now been in existence over a century.

IN the *Transactions of the Academy of Science of St. Louis*, Prof. W. Trelease describes a remarkable instance of "phytobezoar," two balls from 3 to 4 inches in diameter, taken from the stomach of a bull, and composed entirely of the barbed hairs with which the cushions of species of *Platopuntia* are covered.

WE learn from the *Botanical Gazette* that the Secretary of Agriculture for the United States has included in his estimate of the expenditure for the coming year an item of 20,000 dols., to be set aside from the seed fund, for the introduction into the States of valuable economic plants. If sanctioned by Congress, Mr. D. G. Fairchild will be put in charge of the work. His extensive travels and his reputation as a botanist peculiarly fit him for the work.

THE *Botanical Gazette* states that the Biological Survey of the State of Alabama is being pushed and extended as rapidly as limited means will permit. Over 20,000 specimens have been added to the herbarium collection during the present year, including fine series of lichens, mosses, and liver-worts. Much of the success of the work is due to the activity and devotion of Prof. F. S. Earle and Mr. Carl F. Baker, of the Alabama Polytechnic Institute, and of other botanists of the Survey.

THE pitcher-plants of the genus *Nepenthes* are just now engaging the attention of systematic botanists. In the *Journal* of the Royal Horticultural Society for December 1897 is an elaborate article on their growth and culture by Mr. H. J. Veitch, with numerous excellent illustrations, to which are appended some remarks by Mr. F. W. Burbidge. Mr. F. M. Bailey describes the four Australian species in the *Queensland Agricultural Journal*, vol. i. part 5, giving figures of two of them.

THE first number of the new volume (vol. ix.) of the *Journal of Conchology* contains articles and notes of interest to conchologists. The size of the page has been enlarged, and an index is given of the volume just completed. Among the contents is the presidential address delivered by Prof. S. J. Hickson, F.R.S., on "Torsion in Mollusca." Mr. Lionel E. Adams records observations which distinctly show that the slug *Limax maximus* has a sense of smell.

THE eighth part of Mr. Oswin A. J. Lee's attractive work, "Among British Birds in their Nesting Haunts," has just been published by Mr. David Douglas, Edinburgh. The nests illustrated upon the ten fine plates are those of the song thrush, great crested grebe, great skua, tawny owl, bearded tit, common curlew, and siskin. This part appears to conclude the second volume of Mr. Lee's work.

A GOOD general view of physical and chemical science, designed mainly for medical students, is given in the "Physikalisch-chemische Propaedeutik" of Prof. Dr. H. Griesbach. (Leipzig: Engelmann.) The book is being published in parts, and the second part of the second half has just appeared. A knowledge of the principles of physics and chemistry is essential to the student of modern medicine, and Dr. Griesbach has set himself to show how physical methods bear upon medical science. Another part of the work remains to be published, and when it appears, we shall review the book in its completed form.

THE simplest member of the group of the ketoses, of which ordinary lævulose or fruit sugar is the best known representative, is dihydroxyacetone, $CH_2(OH).CO.CH_2(OH)$, which has long eluded the attempts of chemists to isolate it in the pure state, although mixtures in which it is undoubtedly present have been obtained by several investigators by the oxidation of glycerine. Oscar Piloty has now succeeded in preparing this interesting compound in the pure condition, and describes its properties in the current number of the *Berichte*. The starting point for its preparation is the oxime, $CH_2(OH).C:NOH.CH_2(OH)$, which can easily be obtained from the product of the action of formaldehyde on nitromethane, both substances of very simple constitution. When this oxime is treated with bromine, nitrous oxide is evolved and dihydroxyacetone produced. It crystallises well, and has a sweet and cooling taste. In other respects it also shows the well-known characteristics of the sugars, reducing Fehling's solution almost as powerfully as grape sugar, and yielding an osazone with phenylhydrazine. On reduction it is converted into glycerine, a new synthesis of this important compound being thus effected. The production of dihydroxyacetone from formaldehyde is of great interest in view of the important function which the latter is supposed by many to perform in the natural production of sugars in the vegetable organism.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. R. S. Gleave; two Aard Wolves (*Proteles cristatus*, young) from South Africa, presented by Captain Baker; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Lady Pilkington; a Black-backed Piping Crow (*Gymnorhina tibicien*) from Australia, presented by Mr. T. G. F. Winser; two Herring Gulls (*Larus argentatus*), British, presented by the Rev. F. Hopkins; a Japanese Ape (*Macacus speciosus*) from Japan, two Ganga Cockatoos (*Callocephalon galeatum*) from Australia, a Red-tailed Buzzard (*Buteo borealis*) from Jamaica, deposited.

OUR ASTRONOMICAL COLUMN.

A NEW SPECTROSCOPIC BINARY.—In the Harvard College Observatory *Circular* (No. 21) Prof. E. C. Pickering announces that, from an examination of the Draper Memorial photographs, Mrs. Fleming has found that the star A. G. C. 20263, β Lupi, is a spectroscopic binary. The period has not yet been determined, but photographs are being taken for this purpose.

Measures of the spectroscopic binaries μ^1 Scorpii and A. G. C. 10534 show that the relative velocities of the components are approximately 290 and 380 miles respectively. The velocities are therefore much greater than in the case of ζ Ursæ Majoris and β Aurigæ. The separation of some of the lines amounts to as much as nine tenth-metres.

WINNECKE'S PERIODIC COMET.—A short time ago (NATURE, December 23, 1897) we gave Hillebrand's search ephemeris for this comet, and subsequently (January 6, 1898) announced its discovery by Perrine at the Lick Observatory, with a slightly different position from that calculated.

A supplementary note in the *Astronomical Journal* (No. 423) gives the corrections to be made to Hillebrand's ephemeris as

$$\Delta\alpha = + 2\text{m. } 8\text{s.}, \Delta\delta = - 9'.3.$$

Applying these values, we have the following approximately corrected ephemeris.

Berlin M.T.		α h.	m.	s.		δ °	′
1898, Jan. 18·5	...	16	22	8	...	− 7	51·4
,, 22·5	...	16	39	7	...	− 8	46·3
,, 26·5	...	16	54	44	...	− 9	39·6
,, 30·5	...	17	14	57	...	−10	30·6

LEVEL OF SUN-SPOTS.—Much has been said on both sides of the question as to whether sun-spots are concave or convex; and although the Wilsonian doctrine is generally accepted, there are at the same time many difficulties which tell against it.

At first sight it would seem that notches, seen and photographed when a spot is on the limb, go to support the theory; but on the contrary, as Father Sidgreaves pointed out (*Monthly Notices*, vol. lv. p. 285, 1895), they are difficult to account for by it. Again, a more serious objection than this is that both Langley and Frost have found that the ratio of umbral radiation to that of the neighbouring photosphere undoubtedly increases with the distance from the centre of the sun's disc; from this result it would seem that the umbral region whose radiation was measured was above the level of the photosphere, and consequently subjected to less absorption.

In the *Astrophysical Journal* (vol. vi. p. 366), Prof. George E. Hale considers the conclusions which seem to be at variance with the idea that spots are depressions, and suggests that spots may be hollows in comparatively small areas of the photosphere which are raised above the ordinary level; for most admit that the penumbra is at a higher level than the umbra, and it cannot be doubted that penumbral filaments overlie the umbra, and frequently unite to form bridges extending completely across it.

This theory, so far as he has examined it, seems to reconcile the conflicting testimony offered by the supporters of the two views. Notches at the sun's limb are accounted for by assuming that the side of the spot nearest us is somewhat lower than the opposite penumbra, and the darkening of the limb might thus be produced by the smaller radiations of the penumbra. Also, to account for the results obtained by Langley and Frost, it is only necessary to assume that the region of the umbra is slightly raised above the general level of the photosphere.

A VARIABLE BRIGHT HYDROGEN LINE.—From a comparison of the Draper Memorial photographs of the star A. G. C. 9181, taken on different dates, Miss A. J. Cannon has found that the bright hydrogen line $H\beta$ is variable (Harvard College Observatory *Circular*, No. 21). On October 5, 1892, it was invisible. On November 28, 1894, it was about half as bright as the corresponding line in A. G. C. 9198, ω Canis Majoris. On April 27 and 30, 1895, the line in A. G. C. 9181 was distinctly the brighter of the two, while in January 1897 it was again invisible. From a large number of photographs of this object taken recently it appears that this line, which was bright in October 1897, is now, December 27, invisible.

ASTRONOMICAL CONSTANTS.—It will be remembered that Dr. Fr. Porro, in a long letter to NATURE (December 9, 1897) on "Astronomical Constants and the Paris Conference," somewhat depreciated the adoption of some of the constants (especially that of precessional motion), believing "that a general renovation of fundamental astronomy must precede a new and authoritative definition of the numbers that the twentieth century must accept as the more probable values." In the *Astronomical Journal* (No. 423) Prof. Lewis Boss gives his rejoinder to Prof. Newcomb's remarks on his first paper, which criticised the adoption of the constant of precessional motion, and regrets that others have not replied before him. The additional note to Dr. Porro's letter referred to above, although very concise, formed to some extent a reply to Prof. Newcomb; but Prof. Boss's second paper goes into the matter in minuter detail. In conclusion, he thinks that the present time seems singularly inopportune for the adoption of a new evaluation of the precessional motion, and suggests that a new and ingoing investigation of the motion of the equinox should be made; for although the investigation made by Newcomb a quarter of a century ago was exhaustive for its time, new evidence has since accumulated which has not been brought to bear upon the problem; and we may confidently look for still more valuable observations from several observatories within the next ten years.

LONGITUDE OF MADRAS.—We have recently received the "Report on the Determination of the Longitude of Madras," by the officers of the Indian Survey. The difference of longitude actually determined on this survey was that between Greenwich and Karachi, the latter place being at the end of the submarine cable of the "Persian Gulf Telegraphs." It was only necessary to commence at Karachi, for the whole area of India has been covered with a network of longitude arcs, and by their means the difference of longitude between Madras and Karachi had been accurately determined beforehand.

The distance from Karachi to Greenwich, extending over 5197 miles of wire, was divided up into four main arcs, viz.:—Karachi—Bushire, Teheran—Bushire, Teheran—Potsdam, Potsdam—Greenwich, the clock comparisons being made by signalling over the telegraph wire connecting these places. The final result of these observations gives the longitude of Madras as 5h 20m. 59s.·113, with a probable error of ±0s.·0227.

It now rests with the Government of India to decide whether this value should be adopted or not, for a change in the longitude of Madras affects not only British India, but the Malay Peninsula, Tonquin, China, the Dutch Indies, and Australia.

THE ELECTRO-CHEMICAL INDUSTRIES.[1]

TWO months hence there should be celebrated in Como the centenary of Volta's famous discovery, to which we owe the rise of electro-chemistry. Electrical phenomena had been studied long before Volta's time; but if we except the action of the electric spark employed by Cavendish to induce the combination of affinitive gases, no electro-chemical effects had been observed. The analytical power of the voltaic pile was first actually demonstrated by Davy, who made memorable the year 1806 by the electrolytic extraction of potassium from potash. To Faraday, who succeeded Davy, we owe the discovery of the law of electrolytic conduction and the enunciation of the principles of the dynamo. As early as 1842 magneto-electric current generators were employed in the Elkington factories at Birmingham, for electro-plating purposes; and comparatively within recent years the principle of electrotyping has been applied also to copper refining. It is estimated that one-third of all the refined copper required is now produced electrolytically. Metal produced in this way is purer and has a higher conductivity than that produced by the older method, which leaves an admixture of arsenic. The power required is relatively small, and the current density may vary within very considerable limits without detriment to the product and with the gain of great rapidity of deposition. The conditions required are to adapt the strength of the solution to the strength of the current, and when the current density is high to effect a rapid circulation of the electrolyte. Mr. Swan referred to a method devised by himself for producing pure copper wire directly by electrolytic action, so avoiding the slight loss of conductivity due to fusion and drawing. The process, however, was found to be too costly for commercial use.

[1] Abstract of the presidential address delivered by Mr. J. W. Swan F.R.S., before the Institution of Electrical Engineers, January 13.

The electrolytic extraction of metals from their ores is now employed on a large scale, in the case of gold, where it can be profitably applied to the treatment of tailings and waste sludges; of zinc, especially by the recent Hoepfner method of working from the chloride; of aluminium, and of sodium. Aluminium made its first appearance as a commercial product at the Paris Exhibition of 1855. Its price at the time was not far off that of silver. The cost is now equivalent to that of copper, whilst the production has mounted to 2000 tons per annum, and is rapidly increasing. Prof. Richards, well known as the author of the most complete treatise on aluminium, predicts that it is bound to rank next to iron in its production and usefulness to mankind. The principal methods of extraction at the present time are Hall's process, consisting of an electrolytic bath of potassium fluoride, in which alumina produced from bauxite is continuously dissolved; and Heroult's process, in which the solvent consists of cryolite, the double fluoride of aluminium and sodium.

The manufacture of alkali has already undergone many changes the past twenty-five years, one of which is the supersession of the Le Blanc process by the ammonia-soda process of Hemming and Solvay. The electrolytic treatment of brine for the production of soda and chlorine now threatens to displace all the older chemical processes, especially since the introduction of the successful rocking apparatus of Castner and Kellner, in which an end-to-end flow of mercury through three compartments prevents the mixing of the electrolyte, and effects the separation of the sodium and chlorine. A similar industry is the manufacture of chlorate of potash by electrolysis, in a tank divided by a porous partition, with very thin iridio-platinum anodes and iron kathodes. The electrolyte is usually a solution of chloride of potassium maintained at a temperature of 45° to 50° C. The action of this cell results in the formation at the anode of hypochlorite, which is immediately decomposed, with the formation of chloride and chlorate of potassium. In Switzerland and in Sweden this process is worked with great commercial success by the aid of power derived from water.

Amongst the class of electro-chemical processes depending on dissociation and combination at extremely high temperatures, Mr. Swan referred to the manufacture of phosphorus and of carborundum in the Acheson furnace. To the same category belongs the production of calcium carbide and a number of analogous products obtained by Moissan. Calcium carbide, for the production of acetylene gas, is now being manufactured at the rate of 20,000 tons per annum.

The production of ozone, with its secondary derivatives, vanillin and heliotropine, is dependent on another variety of electrical action, in which intermittent or alternating currents of high tension are employed. By the Andreoli and other practical processes, ozone is now being commercially produced and applied to numerous industries, such as the oxidation of oils, the seasoning of linoleum, and the pnrification of brewers' casks.

Such are a few of the principal uses to which Volta's discovery of the galvanic current is being applied. It remains to be seen how far the electrolytic and other electrical processes will supplant the older chemical processes as time goes on. We are probably at present only on the edge of the field that remains to be explored. Mr. Swan's advice to the numerous young electricians who are setting out in life, is that some of them should turn their eyes towards the rich possibilities that await them in this direction. We often hear that the profession of electrical engineering is already crowded. Here at least is a world that still remains to be conquered.

THE BRIGHTON MUNICIPAL SCHOOL OF SCIENCE AND TECHNOLOGY.

THE accompanying illustration shows the external features of the new School of Science and Technology opened at Brighton by the Duchess of Fife a few days ago. The building was designed by Mr. F. J. C. May, the Borough Engineer and Surveyor.

On the ground floor is a large vestibule with mosaic flooring, from which a wide marble staircase leads to the top of the building. A second staircase gives access to the three floors. On each of the floors there is a corridor extending from the front to the back of the building, for a depth of 162 feet, and from these corridors the workshops, class-rooms, lecture theatres, and laboratories open out on each side, with a master's private room for each department. In the basement are situated the boilers and engines for the electric lighting of the building, and for the supply of hot water and steam for the laboratories; here also is a smithy with forges, electrical workshop, carpentering, plumbing, and brickwork and masonry shops, and a dynamo room.

On the ground floor leading from the vestibule are rooms for the Principal, Secretary, Committee, and office; on either side of the corridor are an engineering drawing hall, an engineering workshop, engineering laboratory, metallurgical furnace room, typography shop, and various class-rooms. The workshop is fitted with a Tangye's gas engine, lathes, planing, slotting and drilling machines, &c.

The first floor is devoted mainly to chemistry and physics. The lecture theatres in both departments are fine halls, capable of seating 220 and 120 respectively. The chemical laboratory is fitted for forty-eight students working at one time, and is fully equipped. Besides class and preparation rooms for each department, the accommodation on this floor comprises, among others, rooms for photometry, and advanced physics, chemical research room, balance room, and photographic dark room. The second floor contains a lecture theatre and laboratory for the natural sciences, and lecture and class rooms for dressmaking and cookery.

The day school is a technical college, and provides extended courses in mechanical and electrical engineering, chemistry, natural sciences, and for the Arts and Science degrees of London University. The evening school provides courses in all science subjects, with practical trade classes in building, engineering, printing and chemical trades; languages, commercial subjects, and women's work. The staff of the school is composed as follows:—Principal, C. H. Draper, B.A., D.Sc.; chemistry, M. C. Clutterbuck, B.Sc., Ph.D.; natural science, H. Edmonds, B.Sc.; engineering, G. Armstrong, M.Sc. The total cost of buildings and equipment will be about 25,000*l*.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. W. Ridgeway has been re-elected Disney Professor of Archæology.

Mr. Yule Oldham, University Lecturer in Geography, lectures this term on the Geography of Central Europe, and on Physical Geography, on Mondays and Thursdays respectively. He is also giving an extension course in the town on the Great Explorers, which is largely attended.

Sir Ernest Clarke, Gilbey Lecturer, gives his second series of lectures on Agricultural History and Economics on Thursdays during February, at noon, in St. John's College.

Mr. Osbert Salvin, F.R.S., and Mr. Ainger, Master of the Temple, have been elected to Honorary Fellowships at Trinity Hall.

MR. JOHN D. ROCKEFELLER has just given the Chicago University 200,000 dols., this being in addition to many previous gifts.

THE following are among recent appointments:—Dr. Julius Istvánffy to be professor of botany at Klausenburg; Dr. Alexander Mágócsy-Dietz to be assistant professor of botany at Budapest; and Prof. Dr. Zacharias to be director of the Botanic Garden at Hamburg.

THE Finance Committee of the Corporation have recently reported on the application of the Council of the City and Guilds of London Institute for a renewal of the grant from the Corporation to the funds of the institute. They state from inquiry that the work of the institute has been successfully and economically managed, and the results achieved are fully commensurate with the expenditure involved. The Corporation have, in consequence of this report, voted 400*l*. in respect of last year towards the funds of the institute, to be devoted to the Finsbury Technical College.

A COPY of the Calendar of the University College of Sheffield has been received. It will be remembered that the present College was constituted by Royal Charter last May, and was formed by the amalgamation of three pre-existing institutions—the Firth College, the Sheffield Technical School, and the Sheffield School of Medicine. These institutions had previously worked hand in hand, although under independent governing bodies. By the charter they were merged into one corporation with a single Court of Governors. The new Calendar shows that the College is doing valuable work by providing the people of Sheffield and the district with the means of higher scientific and literary education by University methods of teaching.

AT a meeting of Convocation of the University of London on Monday, the report of the special committee appointed to consider the Commission Bill was adopted. After a discussion the following resolution, recommended by the special committee and moved by Dr. J. B. Benson, was carried, an amendment to it being rejected by seventy-six votes to forty-two: "That this House accepts the scheme embodied in the London University Commission Bill, 1897." The special feature of the resolution adopted rests upon the fact that it was supported by one of the sections that had always hitherto opposed the Cowper scheme. The opponents belong to two classes: the no change—that is, the two Universities section, who are still irreconcileable, and the section which favoured procedure by charter, and not by statutory commission. It was this section that was mainly responsible for the compromise embodied in the Bill of last year—a compromise which has been accepted by all the bodies concerned, and which Convocation has now approved.

THE annual general meeting of the Incorporated Association of Head Masters was held on Thursday last. Resolutions were passed referring to the new regulations of the matriculation examination of the University of London, the dates of scholarship examinations at Oxford and Cambridge, and the training of teachers. At the second day's meeting of the Association, this year's president, the Rev. A. R. Vardy, Head Master of King Edward's School, Birmingham, delivered an address in which he referred to some of the more important educational work accomplished by the Association during the past year. The Rev. R. D. Swallow, in moving "That this Association approves the steps taken by its representatives at the Delimitation Conference held at the Education Department, and hereby adopts the joint memorandum as agreed to at the conference," remarked that the conference, though under the chairmanship of Sir G. Kekewich, was unofficial. It was understood by all that State aid would be needed by secondary schools if they were to take their proper place. The great aim recognised in the memorandum was that the object of secondary schools was to form character in its fullest sense. As to application of principles, the masters of higher grade schools had acknowledged that there must be differentiation. The higher grade schools accepted a place as definitely higher primary schools. These schools had also accepted the assignment of scholarships to primary and secondary schools, and claimed no exclusive use of public funds. The Association also accepted the position that, being primary, these higher grade schools should also be free. There was also a common agreement as to a central authority. After some discussion, the resolution was adopted. A resolution was also carried to the effect that Parliamentary assistance was needed both for the cost of annual maintenance and the provision and equipment of adequate buildings for secondary education.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 16, 1897.—"On the Thermal Conductivities of Single and Mixed Solids and Liquids, and their Variation with Temperature." By Dr. Charles H. Lees, Assistant Lecturer in Physics in the Owens College.

These experiments were undertaken with a view to determining the effect of temperature on thermal conductivities, and the relation between the conductivity of a mixture and the conductivities of its constituents. About thirty solids, liquids, substances near their melting points, and mixtures of liquids, were tested between temperatures of 15° and 50° C., and the following statements embody the results:—

(1) Solids not very good conductors of heat in general decrease in conductivity with increase of temperature in the neighbourhood of 40° C. Glass is an exception to this rule.

(2) Liquids follow the same law in the neighbourhood of 30° C.

(3) The conductivity of a substance does not invariably change abruptly at the melting point.

(4) The thermal conductivity of a mixture lies between the conductivities of its constituents, but is not a linear function of its composition.

(5) Mixtures of liquids decrease in conductivity with increase of temperature in the neighbourhood of 30° C., at about the same rate as their constituents.

"On the Biology of *Stereum hirsutum*, Fr." By H. Marshal Ward, Sc.D., F.R.S., Professor of Botany in the University of Cambridge.

The author has cultivated the mycelium of this fungus obtained from spores, on sterilised wood, and after several months the cultures developed yellow bosses which proved to be the hymenophores bearing the basidia. This fungus has not hitherto been made to produce spores in cultures, and Basidiomycetes generally have rarely been made to do so. The actions of the mycelium on the wood of *Æsculus*, *Pinus*, *Quercus*, and *Salix* are also examined, and this is, so far as known, the first time this has been done with pure cultures.

Mathematical Society, January 13.—Prof. Elliott, F.R.S., President, in the chair.—The President informed the Members of the recent decease of Signor Brioschi, a Foreign Member of the Society, gave a slight sketch of some of his work, and dwelt upon the loss occasioned by his death to the mathematical

world. He then read a letter drawing attention to what was proposed to be done in founding a "Sylvester-Memorial" medal, to be awarded triennially by the Royal Society.—Mr. Love, F.R.S., communicated a paper, by Mr. B. Hopkinson, on discontinuous fluid motion; and Mr. S. H. Burbury, F.R.S., gave a sketch of his paper on the general theory of stationary motion in a system of molecules.—The following papers were briefly communicated from the chair:—Note on a property of Pfaffians, Mr. H. F. Baker; on the intersections of two conics of a given type, and on the intersections of two cubics, Mr. H. M. Taylor; on the continuous group defined by any given group of finite order, Prof. W. Burnside, F.R.S.; on those transformations of coordinates which lead to new solutions of Laplace's equation, Prof. Forsyth, F.R.S.—Mr. G. B. Mathews, F.R.S., exhibited copies of a figure connected with Prof. F. Morley's paper (on the Poncelet polygons of a Limaçon, November 11, 1897).

EDINBURGH.

Royal Society, December 20, 1897.—The Hon. Lord McLaren in the chair.—Dr. C. G. Knott read an obituary notice of the Rev. John Wilson.—Dr. Noël Paton communicated the result of a series of investigations on the life-history of salmon in fresh water. The work was carried on in the Research Laboratory of the Royal College of Surgeons, Edinburgh, for the Scottish Fishery Board, and the results will be embodied in a report to that Society. The following are the names of those responsible for the different parts of the investigation: Drs. F. D. Boyd, J. C. Dunlop, A. L. Gillespie, E. D. W. Greig, G. L. Gulland, Mr. S. C. Mahalanobis, Miss M. J. Newbigin, and Dr. Noël Paton. The objects of inquiry were: To determine whether salmon feed in fresh water; to investigate the factors causing the migrations of the salmon from sea to river, and river to sea; to study the cause of the migrations, and to investigate the chemical changes of the salmon in fresh water. With regard to the first question—Do salmon feed in fresh water?—it is shown that, in fish which have been in fresh water, changes occur in the mucous membrane of the alimentary canal, the cells undergoing degeneration, and desquamation. The digestive activity is feeble; there is a greater number of micro-organisms found in the stomach and intestines, and the proportion of putrefactive organisms is greater. This last may be accounted for by the absence of acid connected with the low digestive power. As to the second and third points of inquiry—the cause and course of migration—the changes in the weight and condition of salmon, from the estuaries and upper reaches, have been studied during the season. There is evidence that migration is not caused by the *nisus* generations but by the state of nutrition. The chemical changes which take place in salmon are interesting. There is a disappearance of solids from the muscles, which is far more than sufficient to yield the solids required by the growing ovaries and testes, and the disappearance of fat from the muscles is more than sufficient to yield the fat of the ovaries. The muscles do not undergo fatty degeneration, but fat is stored between the fibres and in the fibres, and afterwards discharged or used up. The fats are the most important source of the energy of muscular work. The "curd" is due to an excess of soluble proteids, which diminish in the muscles as the season advances. The proteid lost from the muscle is far more than sufficient to yield the proteid of the ovary and testis. The phosphorus stored in the muscles is just sufficient to yield the phosphorus of the growing ovary, but the iron stored in the muscle is not sufficient to yield the iron of the ovaries. Changes in the food value of the fish, and the nature of the pigments in the flesh and ovary are also subjects of investigation.—A note on the passage of water and other substances through india-rubber films, by Dr. R. A. Lundie, was communicated by Prof. Tait.

PARIS.

Academy of Sciences, January 10.—M. A. Chatin delivered the presidential address, in which, after some remarks on botanical classification, he gave brief accounts of the work of members and associates lost by death during the past year, MM. D'Abbadie, Des Cloizeaux, and Schützenberger. The prizes for the year 1897 were awarded as follows:—Francœur Prize, for Geometry, to M. G. Robin; the Poncelet Prize, to M. R. Liouville, for his work on mathematics and mechanics. In Mechanics, the Extraordinary Prize of six thousand francs, between MM. Gossot, Liouville, Decante, and Chéron; the Montyon Prize between MM. Bourguin, Pavie, and Pigache; and an encouragement from the funds of the Plumey Prize to MM. Brillé and Girard. The Fourneyron Prize, on the theory of the motion of bicycles, was not awarded. In Astronomy, the Lalande Prize to M. Perrine for his discoveries of comets; the Damoiseau Prize to M. Hermann Struve; and the Valz Prize to M. Louis Fabry. In Physics, the La Caze Prize to M. Ph. Lénard for his researches on the kathode ray. In Statistics, a Montyon Prize is divided between M. Gustave Bienaymé and MM. Vincent and Burot; a very honourable mention being accorded to M. Lepage and an honourable mention to M. Baudran. In Chemistry, the La Caze Prize to M. Sabatier for his researches on the sulphides of the alkalis and alkaline earths, of boron and of silicon, on the thermochemistry of the hydrated metallic chlorides, on metaphosphoric and nitrosodisulphonic acids, and on the action of the oxides of nitrogen upon metals; the Jecker Prize to M. Haller for his researches in organic chemistry, especially on the derivatives of camphor. In Mineralogy and Geology, the Grand Prize for the Physical Sciences to M. Joseph Vallot for his researches on the meteorology and geology of the High Alps and Pyrenees; the Bordin Prize to M. G. Pruvot for his works on the depth and fauna of the Gulf of Lyons, and the Delesse Prize to M. Œhlert for his paleontological work. In Botany, the Desmazières Prize to M. Jacob Eriksson for his researches on the mode of life and propagation of the numerous forms of blight which attack cultivated graminaceous plants; the Montagne Prize to M. Bourquelot for his work on the physiology of fungi, and the Thore Prize between M. Louis Bordas and M. Sappin-Trouffy. In Anatomy and Zoology, the Savigny and the Da Gama Machado Prizes are not awarded, but honourable mention is accorded to the work of Mdme. la Comtesse de Linden. In Medicine and Surgery, Montyon Prizes are awarded to M. Gaucher for his memoirs on the pathogeny of nephritis and on the diseases of the skin; to M. Zambaco for his work on leprosy in Constantinople; to MM. Rémy and Contremoulins for their Atlas of Radiophotography; and to MM. Marie and Ribout for their radiographic work. Mentions are accorded to M. Fabre-Domergue, MM. Bosc and Vedel, and a third mention to M. Lapique; the Barbier Prize is given to M. de Rochebrune for his treatise on African toxicology, and a mention to M. Lucet for his memoire on *Aspergillus fumigatus* in domestic animals and in incubating eggs; the Bréant Prize to MM. Burot and Legrand for their works on marine epidemics and on mortality in the Colonial army; the Godard Prize to MM. Beauregard and Boulart for their researches on the genito-urinary organs of the Cetacea; the Parkin Prize to Dr. Augustus Waller for his studies relating to the action of carbonic acid and other gases upon the negative variation of excited nerves; the Bellion Prize between M. Auguste Pettit for his researches on the suprarenal capsules, and M. Peron for his anatomical and experimental researches on the tuberculosis of the pleura; the Mège Prize to M. Ph. Tissié; the Lallemand Prize between M. Henri Meunier for his study of the part played by the nervous system in infection of the pulmonary apparatus and M. Gustave Durante for his work on secondary degenerations of the nervous system. Honourable mentions are accorded to M. Voisin, MM. Onuf and Collins, and to M. A. Mercier. The Baron Larrey Prize is awarded to M. Auffret for his monographs on the help to be given to the wounded and shipwrecked in maritime war. In Physiology, the Montyon Prize for experimental physiology is given to M. Delzenne for his works on the coagulation of the blood, the La Caze Prize to M. Röntgen for the discovery of a new and powerful instrument of physiological and therapeutical research; the Pourat Prize to M. Kaufmann; the Martin Damourette Prize to M. L. Guinard for his memoirs on the physiological effects of some of the opium alkaloids, and on the causes of certain accidents in anæsthesia, and the Philipeaux Prize to MM. Courtade and Guyon. In Physical Geography, the Gay Prize is accorded to M. Charles Flahault for his memoir on the study of the French Mediterranean region from the point of view of the geographical distribution of plants. Of the General Prizes, the Montyon Prize (unhealthy trades) is not awarded this year, but mentions are accorded to MM. Masure, Arnaud, and Magitot. The Cuvier Prize is given to Prof. Marsh for his geological work in the United States; the Trémont Prize to M. Frémont; the Gegner Prize to M. Paul Serret; the Petit D'Ormoy Prizes to the late M. Tisserand (Mathematical Sciences); and M. Gosselot (Natural Sciences); the Tchiatcheff Prize to M. Obrutschew; the Gaston Planté Prize to M. André Blondel; the Cahours

Prize between MM. Lebeau, Hébert, Tassilly, and Thomas; the Saintour Prize to M. G. André; the Prize founded by Mdme. La Marquise De Laplace to M. Crussard, and the Prize founded by M. Félix Rivot to MM. Crussard, Gourguechon, Bertrand, and Bruneau.

NEW SOUTH WALES.

Royal Society, November 3, 1897.—The President, Henry Deane, in the chair.—The effect of temperature on the tensile and compressive properties of copper, by Prof. Warren and Mr. S. H. Barraclough. This investigation was carried out on some fifty copper test pieces. The temperature range attained was from 25° F. to 535° F., the temperatures being measured by certified mercurial thermometers. The chief conclusions arrived at were: (*a*) The relation between the ultimate tensile strength and the temperature may be very closely represented by the equation $f = 32,000 - 21\ t$, where f is the tensile strength expressed in pounds per square inch, and t is the temperature expressed in degrees F. (*b*) Temperature does not affect the elongation or contraction of area in any regular manner: and at any one temperature the variation in these two quantities is so variable for different specimens that no particular percentage could be included in a specification for the supply of copper. (*c*) The elastic limit in tension occurs at about 5400 lbs. per square inch: this limit probably decreases rapidly with increase of temperature, but the differences in the behaviour of individual specimens are so great as to prevent the determination of the relationship between the two quantities. (*d*) The elastic limit in compression occurs at about 3200 lbs. per square inch: it decreases with increase of temperature, the relationship between the two being more regular than in the tensile tests. (*e*) The rate of permanent extension and compression increases rapidly with increase of temperature.—Aurora Australis, by H. C. Russell, C.M.G., F.R.S. This paper contained a list of auroral displays in the southern hemisphere during 1897, also a detailed account of one which was observed by the captain and officers of the R.M.S. *Aorangi*, on April 20, 1897, when the ship was in long. 96° W. and lat. 47½° S.—The basalts of Bathurst and the neighbouring districts, by W. J. Clunies Ross. In this paper the character of the basalt occurring in the neighbourhood of Bathurst, on the Bald Hills, and other hills in the vicinity, was described. Specimens from various localities have been obtained, microscopic sections cut from them, and chemical analysis made. It has been found that there are some differences in the microscopic structure of the rocks from hills close together, but the chemical analysis shows them to be all closely related. The silica was found to be about 47 per cent., but reached 50 per cent. on Mount Pleasant. The alumina, oxide of iron, lime, and magnesia were also determined. For comparison with the Bathurst basalt, which no doubt originally flowed as a lava from some centre of volcanic activity, and in order to trace the source from which it came, specimens were examined from all the places within forty miles of Bathurst, where basalts are known to occur.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 20.

ROYAL SOCIETY, at 4.30.—The Relations between Marine Animal and Vegetable Life: H. M. Vernon.—(1) The Homogeneity of Helium; (2) Fergusonite, an Endothermic Mineral: Prof. W. Ramsay, F.R.S., and Morris W. Travers.—On the Modifications of the Spectra of Iron and other Substances radiating in a Strong Magnetic Field: T. Preston.

ROYAL INSTITUTION, at 3.—The Halogen Group of Elements: Prof. Dewar, F.R.S.

SOCIETY OF ARTS, at 4.30.—Recreations of an Indian Official: Right Hon. Sir Mountstuart Elphinstone Grant Duff, G.C.S.I., C.I.E., F.R.S.

LINNEAN SOCIETY, at 8.—On the Larval Hyobranchial Skeleton of the Anurous Batrachians, with special reference to the Axial Parts: Dr. W. G. Ridewood.—On the "Abdominal Pore" in the Myxinidæ: R. H. Burne.

CHEMICAL SOCIETY at 8.—Ballot for the Election of Foreign Members.—The Action of Caustic Alkalies on Amides: Dr. Julius B. Cohen and Edward Brittain.—The Formation of Monomethylaniline from Dimethylaniline: Dr. Julius B. Cohen and H. T. Calvert.—Note on the Aluminium-Mercury Couple: Dr. Julius B. Cohen and H. T. Calvert.—Action of Chloroform and Alkaline Hydroxides on the Nitro-benzoic Acids: W. J. Elliott.—Researches on the Terpenes. II. On the Oxidation of Fenchene: J. Addyman Gardner and G. B. Cockburn.—The Preparation of Pure Iodine: Dr. Bevan Lean and W. H. Whatmough.

FRIDAY, JANUARY 21.

ROYAL INSTITUTION, at 9.—Buds and Stipules: Sir John Lubbock, Bart., M.P.

PHYSICAL SOCIETY, at 5.—On Electric Signalling without Conducting Wires: Prof. O. Lodge, F.R.S.—A Tesla Oscillator will be exhibited by Prof. S. P. Thompson, F.R.S.

TUESDAY, JANUARY 25.

ROYAL INSTITUTION, at 3.—The Simplest Living Things: Prof. E. Ray Lankester, F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Anniversary Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Reservoirs with High Earthen Dams in Western India: W. L. Strange.

ROYAL VICTORIA HALL, at 8.30.—Mars as a World: R. A. Gregory.

THURSDAY, JANUARY 27.

ROYAL SOCIETY, at 4.30.

ROYAL INSTITUTION, at 3.—The Halogen Group of Elements: Prof. J. Dewar, F.R.S

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Notes on the Electro-Chemical Treatment of Ores containing the Precious Metals: Major-General Webber, C.B.

FRIDAY, JANUARY 28.

ROYAL INSTITUTION, at 9.—Instinct and Intelligence in Animals: Prof. C. Lloyd Morgan.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Condensing Apparatus: H. Williams.

BOOKS RECEIVED.

BOOKS.—The Tutorial Chemistry: Dr. G. H. Bailey. Part 2. Metals (Clive).—On a Sunshine Holyday: The Amateur Angler (Low).—Nature's Diary: F. H. Allen (Gay).—An Elementary Course of Practical Organic Chemistry: F. C. Garrett and A. Harden (Longmans).—The Essentials of Experimental Physiology: Dr. T. G. Brodie (Longmans).—Premature Burial: Fact or Fiction?: Dr. D. Walsh (Baillière).—The Tailless Batrachians of Europe: G. A. Boulenger, Part 1 (Ray Society).—A First Year's Course of Experimental Work in Chemistry: Dr. E. H. Cook (Arnold).—Views on some of the Phenomena of Nature: J. Walker (Sonnenschein).—Korea and her Neighbours: Mrs. Bishop, 2 Vols. (Murray).—United States Geological Survey, Monographs xxv.-xxviii (Washington).—Annuaire de l'Académie Royale des Sciences, &c., de Belgique, 1898 (Bruxelles).—The Purification of Sewage and Water: W. J. Dibdin (Sanitary Publishing Company, Ltd.).—Proceedings of the Chemical and Metallurgical Society of South Africa. Vol. 1 (Edinburgh. Hunter).—Audubon and his Journals: M. R. Audubon, 2 Vols. (Scribner).—The Observer's Atlas of the Heavens: W. Peck (Gall).—The War of the Worlds: H. G. Wells (Heinemann).

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THURSDAY, JANUARY 27, 1898.

THE HOPE DEPARTMENT AT OXFORD.

The Hope Reports. Vol. i., 1893-97. Edited by Edward B. Poulton, M.A., F.R.S., Hope Professor of Zoology in the University of Oxford. (Printed for private circulation.)

SINCE the death of Prof. Westwood and the appointment of his successor, the editor of the volume of Reports under consideration, the Hope Museum has gradually been undergoing expansion and regeneration. The collections are being overhauled and reclassified; the types are being identified as far as possible and carefully labelled, and the special British collections are being rearranged so as to preserve their historical interest. This development of the department under the care of Prof Poulton has been noted with satisfaction by those specialists who from time to time visit Oxford: and although the endowment, both for curatorship and equipment, is very limited, it must be conceded that the present Professor is doing his best to carry out the objects for which a museum of this kind exists, viz. to preserve specimens in such a way as to enable them to be available for use by students with the confidence which attaches to authentic records of date, locality and captor. This, at least, is the ideal which the Professor has set before himself, and it is only a matter of profound regret that the advanced years and declining health of the late distinguished occupant of the Rev. F W. Hope's foundation should have thrown upon his successor such an immense amount of purely mechanical labour. A good beginning has been made with the Lepidoptera with the co-operation of Colonel Swinhoe, Dr. F. A. Dixey, Prof. Sidgwick, and others; but many years must elapse before the other and less favoured groups are reduced to anything like the same degree of order.

The conditions attaching to such an endowment as that of Mr. and Mrs. Hope have with the advancement of science and the increase in the number of private collections undergone complete modification. Although as a collection of insects of all orders the museum as it exists is second only in rank to the National Collection, the means provided are barely sufficient for its maintenance and leave very little for its increase. With such competing forces as the British Museum, Mr. Walter Rothschild's museum at Tring, and the wealth of many other private collectors, it is hopeless to look for any substantial additions to the Oxford collections excepting through individual benefactors. It is very encouraging, therefore, to find in the two official reports of the Professor on the work of his department, that many valuable contributions have been made by entomologists since he came into office, and more particularly may be mentioned the magnificent addition to the butterflies presented by Messrs. Godman and Salvin, which is characterised as "the largest accession to the department during recent years," and which was formally accepted by a decree of Convocation on May 11, 1897, when a further decree conveying the thanks of the University to the donors was also passed unanimously.

The foregoing remarks relate to the work accomplished in the development of the museum as a museum; but there is another side to the work of the Hope Department which must not be lost sight of, and of this side we are reminded by the volume of Reports. This volume is most appropriately prefaced by the portraits of the makers of the department, Mr. and Mrs. Hope and the late Prof. Westwood. In his prefatory remarks the editor says:—

"In the present state of zoological science, it is impossible to make use of existing knowledge in the careful study of a large amount of material without adding to that knowledge. Research after the various kinds of knowledge which have been prized by mankind during successive ages was of old the prominent function of the University; and although obscured during the recent generations by excessive devotion to the examination system, may still be claimed as an academic duty and high privilege second to no other in importance."

With this statement every science worker in this country will agree, and the signs of activity displayed in this new departure on the part of the Hope Professor will be cordially welcomed. The papers composing this volume are sixteen in number, and are reprints of papers which have already appeared in the publications of various societies. For the most part these papers embody "researches" as distinguished from purely descriptive systematic work, and that is why we consider the issue of the volume to mark a new departure. The contents of the various papers are already before the scientific public, and need only be mentioned here. Prof. Poulton's contributions consist of his address to the Zoological Section of the British Association at Liverpool on the age of the earth, his address on "Theories of Evolution" to the Boston Society of Natural History, his paper on Dr. Prichard's anticipation of modern views of evolution, from *Science Progress*, papers on the courtship of European Acridiidæ, and on the sexes of larvæ emerging from successively laid eggs of *Smerinthus populi* from the *Transactions* of the Entomological Society of London, and a paper on the colours of Lepidopterous larvæ derived from plant pigments, from the *Proceedings* of the Royal Society. Dr. F. A. Dixey also presents us with most encouraging signs of scientific activity from the department. Five papers relating respectively to mimicry, to the phylogeny of the Pierinæ, and to the interpretation of Mr. Merrifield's experiments on temperature variation in Lepidoptera are contributed by him. Another set of contributions are from the pen of Mr. Garstang, who writes on the habits and respiratory mechanism of *Corystes*, on the function of the antero-lateral denticulations of the carapace in sand-burrowing crabs, and on the morphology of the Mollusca. Mr. Garstang's papers on Crustacea should be read by all who are interested in the question of the utility of specific characters. The only paper approaching systematism is by Mr. Schaus, who gives a list of Mr. Walker's American types of Lepidoptera in the museum, and for this lepidopterists on both sides of the Atlantic will be grateful.

It will be gathered from this notice that the Hope Professor has rendered a good account of his office since his appointment. The plan of issuing such Reports,

which has been adopted from the example set by the Linacre Professor, is an excellent one, and cannot but help to keep alive the public interest in the work of the department. With the lapse of time and the arrangement and coordination of the collections we may look for further contributions from Prof. Poulton himself in those branches of insect bionomics with which his name is so widely connected. R. M.

WEAPONS OF EARLY MAN IN BRITAIN.

The Ancient Stone Implements, Weapons, and Ornaments of Great Britain. By Sir John Evans, K.C.B. Second edition. Pp. xviii + 747. (London: Longmans, Green, and Co., 1897.)

FOR some years past it has been felt by students of anthropology that the limits of their science were being pushed so far in every direction by various enthusiastic workers in almost every country of the inhabited world, that it was high time for some competent hand to gather together the facts which lay scattered broadcast in the publications of learned societies and private students, so that they might be available for general use in a collected form. It seems that this idea also filled the mind of one, at least, of our veteran teachers, and the result of its existence is the second edition of Sir John Evans' famous work on the "Ancient Stone Implements, Weapons, and Ornaments of Great Britain." It is now some twenty-five years since the first edition of this valuable book saw the light, and the accuracy and plain statement of facts, which were its chief characteristics, secured for it at once a place of high authority. In those early days of the history of British stone-lore scientific collectors of facts were few, and men like the late Sir Wollaston Franks, the Rev. William Greenwell, and Mr. J. Anderson of Edinburgh, who attempted to arrange their specimens with a proper regard to hard facts, were looked upon with suspicion by a large mass of collectors and "antiquaries" whose chief interest in antiquities lay not in the objects themselves, but in the wonderful stories which they could tell about them. A visit to certain local museums not many scores of miles from London will to this day show what measure of learning was possessed by those who labelled and arranged them about thirty years ago, and we make bold to say that general ignorance and specific blunders in such matters can only be cleared away by the publication of good works, such as that before us, written in plain language and published at a reasonable price.

Sir John Evans' book is so well known that it would be a waste of the reader's time to attempt to describe it here, but it will not be out of place to note wherein the second edition differs from the first. Many of the excellent illustrations by Mr. Swain have been retained, but a number of new ones have been added; the text, which filled six hundred and twenty-two pages in the first edition, now fills seven hundred and nine. The indexes, which formed such a useful part of the first edition, are more than double as large, and many a reader will thank Mrs. Hubbard, who is responsible for them, for lightening his labours. In general form, size of type, &c., both editions are alike.

But in the quarter of a century which has passed since Sir John Evans issued the first edition of his work, many striking discoveries of stone weapons and other objects have been made. Excavations which have resulted in "finds" of great value have been carried on in many parts of England, whilst diggings in Egypt and elsewhere in the East have brought to light facts which in some cases have upset our most cherished and most ancient convictions. With new facts coming to hand continually, Sir John Evans has found it possible to generalise and to make deductions such as would, a few years ago, have been impossible; and a perusal of some of the chapters of his book reveals the startling fact that the inhabitants of parts of Asia, Africa, and Europe, situated at very remote distances from each other, made their weapons of the same materials, in the same shape, and in the same way. Indeed, it is very hard not to assume that such peoples either came from the same stock, or had some means of communication which until now has remained unsuspected.

In addition to well-known collections such as those of the Rev. W. Greenwell, General Pitt-Rivers, and certain public museums, Sir John Evans has drawn his facts from the examination of other collections in this country and on the continent which, fortunately, he has had time and opportunity to visit; besides these, he has been in communication with scholars and students in many parts of the world who have forwarded him antiquities which they have found or come across, and he has thus been in an excellent position to read, mark, and note the results of his observations for the benefit of the readers of the second edition. For the collector pure and simple the section of the book which ends on p. 639 will be more important than the rest, but for the general student who interests himself in the questions of the antiquity of man and the date of his appearance upon earth, and in theories of river-drift and flood-deposit, the chapters which follow will prove the greatest attraction. In only a few small points, in obedience to the authority of new information, Sir John Evans has modified the views which he expressed in his first edition; this fact, taken together with the number of discoveries made in the realm of British stone-lore during recent years, shows how carefully his work was conceived and executed. Our thanks are due to him for making available to each and all the stores of his mature learning and wide experience, and we can only hope that at some future period he may see his way to put on record some of the deductions which he must have made on many points, and the theories on difficult problems which he must have formed. Coming from him they would have a special value.

CLIMATOLOGY OF THE GLOBE.

Handbuch der Klimatologie. Von Julius Hann. Second edition. 3 vols. Pp. 1360. (Stuttgart: Engelhorn, 1897.)

THIS work, which belongs to the series of "Geographischer Handbücher" issued by Dr. Ratzel, will be welcomed by all meteorologists. It is the second edition of the work under the same title which appeared in 1883. That it has been entirely rewritten and enlarged

appears from the fact that while the original single volume contained 764 pages, the work has now grown to three volumes, numbering, in all, 1360 pp. On reading it one cannot but be astonished at the extent of erudition and research which is displayed on every page.

Naturally, in a work dealing with the climatology of the whole globe, we do not expect to find detailed tables of temperature or of rain for every country; what we do find are careful excerpts of data from typical stations, illustrated by frequent extracts from travels and other works describing personal experiences in distant regions. Thus, for Siberia we have copious citations from Middendorff and Adolph Erman, for Hindostan from Blanford, for Java from Junghuhn, and so on.

The first volume, 400 pp., deals with the main factors of climate, and then passes on to general climatology. It treats, firstly, of solar climate, or that which would result from the action of the sun alone; and, secondly, of physical climate under the two heads of (*a*) Land and Sea Climate and (*b*) Mountain Climate. On the latter subject Dr. Hann is, admittedly, the highest living authority, and his remarks on the effect of mountains, on such winds as the Scirocco, the Bora, and the Mistral, as well as on the various air movements, in different directions in different countries, which are all classed under the generic term of Föhn winds, are well deserving of careful study.

Dr. Hann points out that every spot along the northern Mediterranean shores, which is famed for the mildness of its winter climate, owes this entirely to the immunity from the access of cold winds afforded to it by a mountain range in close proximity.

Vol. i. closes with a brief notice of the various theories of climatic changes, cyclical and otherwise, which have of late been put forward by Croll, Brückner, and others.

Vol. ii., with 384 pp., is devoted to the climatology of the tropics. This is necessarily treated in a more or less incomplete manner, for while the data for the interior of tropical Africa are fragmentary, next to none are attainable for the entire tropical region of Brazil, and very little for the tropical Pacific Islands.

To show what knowledge we have already gained of the climates of the east and west coasts of Africa, respectively, in low latitudes, we may say that the east and west coasts each occupy some fifty pages, while the interior is but briefly discussed.

Vol. iii. is even fuller than its predecessors, mounting up to 572 pages. It deals with the meteorology of the temperate and frigid zones. For the former, at least, the literature is far more abundant than that for the tropical countries, and a careful selection has been made.

The sections on East Siberia and on the United States are especially interesting, as showing how the difference in the trend of the mountain chains affects the climate of each region. The chain in the west of the two Americas lies close to the coast, and sweeps westwards towards the Bering Straits, whereas in Europe the Norwegian mountain line turns to the eastward. Accordingly, in the New Continent the influence of the Pacific Ocean is reduced to a minimum, while in the Old that of the Atlantic extends far inland.

Comparing the United States with Eastern Asia, we find that the whole of the States are exposed to the visitation of icy northerly winds owing to the absence of cross-mountain ranges of any considerable altitude. In Asia high mountains and tablelands effectually check the outflow of chilled air from the Siberian centre of cold, about the valley of the Lena.

The notices of Chili, Argentina, and the whole southern part of South America are extremely interesting reading.

The account of Arctic and Antarctic meteorology is very full, and as the data from all the expeditions of the years 1882-83 have been utilised, the information afforded is much more complete than any before presented to the public. Dr. Hann expresses his regret that the only publication of the scientific results of the English expedition of 1875-76, under Sir G. Nares, has been in a Blue-book, and is therefore almost inaccessible to men of science.

The entire work is eminently what the Germans call "epoch-making," and it is only to be regretted that, as it is in German, readers in England will be but few.

OUR BOOK SHELF.

Natürliche Schöpfungs-geschichte; gemeinverständliche wissenschaftliche Vorträge über die Entwickelungslehre. Von Ernst Haeckel. Ninth edition. Pp. lxii + 831. Portrait and thirty plates. (Berlin: Georg Reimer, 1898.)

THIS well-known book has now reached its ninth edition. The original form is retained, but many corrections have been made, and the phylogenies have been brought up to date according to Prof. Haeckel's interpretation of newly-ascertained facts.

The author's aim is to simplify the enormous mass of observations, reasonings and theories which we call biology, and to show that it can all be explained by a relatively few general principles. The worker at any special group of plants or animals will often, perhaps usually, find it impossible to satisfy other specialists as to the systematic relations of all the forms on which he has been engaged, or to clear up those vestiges of remote history which some of them may present. Haeckel, however, does not hesitate to deal with the whole animal and vegetable kingdoms, placing and deriving all the chief groups. Most philosophical naturalists find it hard to explain any fact of nature adequately, and put forth their conclusions timidly, as those who look for a day of fuller knowledge. Haeckel offers us a theory of development, by which all the chief groups of biological phenomena can be "mechanically explained and understood" (p. 790). This cheerful conviction that we already hold the main clues to a philosophy of nature is very engaging to those who have no great sense of responsibility as teachers or writers; it rouses the most profound scepticism in those who have found by trial how little we can really explain. Haeckel's "Schöpfungs-geschichte" is based upon wide knowledge; it has been corrected many times; it is clear and persuasive. Nevertheless, there is no book of our own day of which we should more confidently predict that a future and not distant generation will find it grotesquely inconsistent with natural fact. There are books which after many generations still seem modern; Malpighi and Swammerdam have written such. There are also books which become antiquated in the life-time of the author, and to our mind the book before us is one. It wants altogether the reserve, scepticism and modesty which were the safeguards of Lyell and Darwin when treating subjects of such unfathomable complexity.

A special student, critically examining that one of Haeckel's phylogenies with which he is chiefly concerned,

would, we believe, find that it rests upon daring and gratuitous assumptions. The present writer distinctly affirms that this is true of the table of articulates on p. 575, and of the table of insects on p. 595. Unfortunately, the criticism by which this opinion might be justified would be too technical, and especially too lengthy, for the columns of NATURE. L. C. M.

Analytic Geometry for Technical Schools and Colleges. By P. A. Lambert, M.A. Crown 8vo. Pp. xii + 216. (New York: The Macmillan Company. London: Macmillan and Co., Ltd.).

THE great prominence given in the earlier chapters to curve-tracing, and the fact that the plotting of both algebraic and transcendental curves takes precedence of more purely mathematical treatments of the line, circle, and conic, renders this text-book peculiarly adapted in many respects to the requirements of engineering and other students whose main object is to obtain a thorough drilling in graphic methods. Such a student would do well to be guided by a teacher, as some early sections and examples are rather hard for first reading. In the later chapters the author has attempted to give an account of the properties usually treated in books on "Analytical Conics," together with the graphic representation of imaginaries, and an introduction to analytical geometry of three dimensions. With this portion, he can hardly be said to have been so successful. His treatment of such matters as tangents, diameters, asymptotes, and poles and polars, is very incomplete, and not calculated to bring into prominence those general properties which render such lines of importance in the geometry of conics; indeed, we might go further and say that even where no actual inaccuracies exist in the text, it would require a previous knowledge of the subject in order to enable a student to read between the lines sufficiently to avoid falling into error. Moreover, too little attempt is made at "graduating" the course, easy and difficult sections alternating with each other, and there being rather a lack of that sequence and arrangement which is so helpful to the beginner. Those who find life too short to learn conics up to examination standard will, however, be able, by the aid of the examples and a little outside help, to obtain a very fair superficial knowledge of the subject.

The Valley of Zermatt and the Matterhorn. A Guide. By Edward Whymper. With illustrations and maps. Pp. xvi + 212. (London: John Murray, 1897.)

THIS compact little volume in paper covers is designed on the same plan as the author's Guide to Chamonix, which was recently published. From so prominent a mountaineer much may legitimately be expected in a guide to one of the greatest climbing-centres in the Alps, but it is almost a surprise to find so very much which is available for the tourist whose bent does not incline towards feats of physical endurance. The first chapter is devoted to the early history and rise of Zermatt, then comes a history of the Matterhorn in four chapters, in which Mr. Whymper nerves himself to tell once more the terrible tragedy of his first ascent. The practical part of the Guide follows; hints as to the best way of reaching Zermatt, particulars regarding the valley and the village, and a carefully arranged series of excursions from that favourite centre. Excursions from the Riffelalp and other places are also described, and the opportunity is taken of sketching the mountaineering history of Monte Rosa. This blending of historical associations and anecdotes with practical hints and instructions is perhaps the most interesting feature of the Guide.

With the exception of some lists of altitudes of peaks and passes, and a geological section of the Matterhorn with an explanatory note in French by Signor F. Giordano, there is no special attention bestowed on the scientific aspects of nature-study.

The illustrations are examples of Mr. Whymper's own art, and no more requires to be said concerning them.

Practical Forestry. By C. E. Curtis. Second edition revised. Pp. viii + 124. (London: Crosby Lockwood and Son, 1898.)

NO doubt a forester might gain some advantage from a perusal of this book, provided he read it with caution. But he would encounter several statements with which he would have a difficulty in agreeing. For instance, the author deliberately says, "To purchase trees, or to plant by contract, are also means to ensure failure." If that were true, it would be small wonder that the results of forestry are not in all cases satisfactory in England, where quite 90 per cent. of the plantations have been formed in the ways that the book condemns. A most serious slip occurs in the statement of the rule for ascertaining the cubical contents of a tree, where "square of the girth" appears instead of "square of the *quarter* girth." This would not mislead a practical man, but it might lead to most unpleasant consequences in the case of a student who made use of the book in preparing for an examination.

Agriculture in some of its Relations with Chemistry. By F. H. Storer, Professor of Agricultural Chemistry in Harvard University. 3 vols. Pp. iv + 620, iv + 602, and vi + 679. (London: Sampson Low and Co., Ltd., 1897.)

WHEN a book has passed through seven editions in ten years, and has grown from two to three volumes, there can be no doubt that it has been appreciated. This bulky work deals in a discursive way with the subjects of soil, manures, and crops, and with many things connected with the management of land; the feeding of animals is not discussed. A great deal of information is brought together: one admires the extent of the author's reading; but after a lengthy perusal of his diffuse statements we rise with the feeling that we have not gained any really scientific grasp of the subject. The matter placed before the reader has, in fact, not been digested, or the experimental results correlated; the book is a miscellany by a very well-informed man. One good feature of the book is its practical character; the intelligent farmer will probably enjoy it better than the man of science. R. W.

Glimpses into Plant-Life. An Easy Guide to the Study of Botany. By Mrs. Brightwen, F.E.S. Pp. 351. (London: T. Fisher Unwin, 1897.)

THIS is a pleasant little book, and will be read with interest by many who enjoy a country ramble or rural life from the naturalist's point of view. The authoress displays a first-hand acquaintance with the plants concerning which she discourses; and if there are occasional slips when she deals with matters physiological, they will be readily pardoned for the sake of the generally excellent character of the book. There are some errors, however, which might easily have been avoided, *e.g. aëroid* for *aroid*, on p. 62. Some of the photographs of trees and bark are decidedly good.

Premature Burial: Fact or Fiction? By Dr. David Walsh. Pp. 49. (London: Baillière, Tindall, and Cox, 1897.)

SO much news is published with the idea of creating a sensation, that Dr. Walsh's critical examination of some of the stories of premature burials is very welcome. The general conclusion arrived at is that "the theory of frequent premature burial is unsupported by exact evidence; in other words, it occupies the position of a mere popular belief or fable."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Diagram of Heredity.

THE law of heredity which was formulated by myself in a memoir entitled "The average Contribution of each several Ancestor to the total Heritage of the Offspring" (*Roy. Soc.*, June 3, 1897, and NATURE, July 8, 1897), and which, as I am exceedingly gratified to learn, is now strongly corroborated by an independent investigation, has recently been illustrated by a useful diagram. This was devised by Mr. A. J. Meston, of Allen Farm, Pittsburg, Mass., U.S.A., and communicated by him to the *Horseman* (Chicago, December 28), the leading American newspaper on horsebreeding, together with a popular explanation of the law in question. Believing, as I do, and I am not now alone in the opinion, that the law is a real advance in hereditary science, I think that Mr. Meston's diagram deserves a place in your columns, as conveying in a very intelligible form the chief features of the law.

These are that the total *heritage* of the offspring is derived as follows. The two parents between them contribute *on the average* one half of each inherited faculty, each of them contributing one quarter of it. The four grandparents contribute between them one quarter, or each of them one sixteenth; and

so on, the sum of the series $\frac{1}{2} + \frac{1}{4} + 1/8 + 1/16 +$ &c. being equal to 1, as it should be. It is a property of this infinite series that each term is equal to the sum of all those that follow: thus $\frac{1}{2} = \frac{1}{4} + 1/8 + 1/16 +$ &c.; $\frac{1}{4} = 1/8 + 1/16 +$ &c., and so on. The prepotencies or subpotencies of particular ancestors, in any given pedigree, are eliminated by a law that deals only with *average* contributions, and the varying prepotencies of sex in respect to different qualities, are also presumably eliminated. Corrections for these can of course be made in any particular pedigree, taking care that the corrected series still amounts to 1 exactly.

It should be borne in mind that the word "Heritage" has a more limited meaning than "Nature," or the sum of the inborn qualities. Heritage is confined to that which is inherited, while Nature also includes those individual variations that are due to other causes than heredity, and which act before birth. Now individual variation in a race that is stable, must have a destructive as often as a constructive effect. Consequently its effects balance one another in *average* results, and disappear from a law which deals only with these.

The area of the square diagram represents the total heritage of any particular form or faculty that is bequeathed to any particular individual. It is divided into subsidiary squares, each bearing distinctive numbers, which severally refer to different ancestors. The size of these subsidiary squares shows the average proportion of the total heritage derived from the corresponding ancestors. The distinctive numbers are the same as those which I employed many years ago in connection with the "Family Records" with which I was at that time engaged: they were found both then and subsequently to be very convenient. The Subject of the pedigree is numbered 1. Thenceforward whatever be the distinctive number of an ancestor, which we will call n, the number of its sire is $2n$, and that of its dam is $2n + 1$. All male numbers in the pedigree are therefore even, and all female numbers are odd. To take an example—2 is the sire of 1, and 3 is the dam of 1; 6 is the sire of 3, and 7 is the dam of 3. Or, working backwards, 14 is a male who is mated to 15; their offspring is 7, a female, who is mated to 6; their offspring is 3, a female, who is mated to 2, and their offspring is 1, the Subject. The connection of all this with the binary system of notation is obvious, and need not be further alluded to. [In Mr. Meston's own diagram, the number 1 is assigned to the sire, and 2 to the dam, and so on. This detracts from the simplicity of the nomenclature, and therefore I do not adopt that part of his diagram.] The distinction between the male and the female squares is made still more conspicuous by colouring the latter; but, yielding to the exigencies of printing, I have replaced colour by printers' ink. So all male squares in my version of Mr. Meston's diagram have white grounds and black numerals, and all female squares have black grounds and white numerals.

The numbered squares could be continued indefinitely: in this small diagram they cease with the fourth generation, which contributes a 16th part of the total heritage, therefore the whole of the more distant ancestry, comprised in the blank column, contribute 1/16th also. FRANCIS GALTON.

"Some Unrecognised Laws of Nature."

PRESSURE of important business has prevented me from writing ere this to claim space in your columns to enter a protest against the misrepresentations, as well as the whole tone, of the review—which appeared in your columns of the 9th ult.—of the above work, in which I have had the privilege of assisting during the past six years. Heretics have long learned not to expect mercy, or even to look for justice, at the hands of the orthodox. But from a reviewer who, oblivious of the proverb *Qui s'excuse s'accuse*, warned his readers that he at least was "not one to regard lightly the danger of summarily rejecting a germ of new discovery because it happens to conflict with orthodox opinions," we have a right to expect something very different from the venomous outpourings and direful warnings and threats that might flow quite naturally from an irate theologian when reviewing a work which strikes a blow at the very foundations of his dogmas and doxies. And this is the very head and front of our offending, that, heedless of authority, we regard "the whole doctrine of 'energy,' with all its astounding and contradictory corollaries," as absurd; as the product of the infantile, and necessarily anthropomorphic, imagination of primitive man; and that we have attempted to show how phenomena may be accounted for without having recourse to such figments of the imagination. In this we may have succeeded or not; the immediate verdict will largely, if not entirely, depend on the mental attitude of the judge, and for the ultimate verdict we must be content to wait. But your reviewer may find some comfort in the assurance that the *facts* of science, slowly accumulated through long ages, would not be affected, nor need the human race necessarily be plunged "once more into pre-Galilean ignorance," even if all the assumptions, the metaphysical conceptions—of ethers, "dead" matter, "animating" energy, &c.—on which current explanations of these same facts are based, were summarily consigned to the limbo of similar long-forgotten "working hypotheses." And it is these hypotheses we assail, not the facts.

Of his criticisms of the fundamental principles, or rather principle, on which all our explanations are based, I need say nothing, for I can safely leave them to the judgment of all who take the trouble to read our work. I may mention, however, that his review is itself a strong *a posteriori* verification of the law of persistence in its application to psychological phenomena. But I must protest against the, conscious or un-

conscious, misrepresentation involved in taking certain speculative conclusions—which in the light of current conceptions we know and point out must *appear* absurd—away from their context, and holding them up to ridicule as if they had been advanced as well-ascertained facts; and all these from a chapter the first words of which read—"This chapter will be mainly speculative."

In conclusion I would thank your reviewer for one useful piece of criticism in his eight-column notice—a notice, by the way, to say that the book is not worth noticing—in which he points out a loosely and badly worded paragraph on page 77, the real purport of which, however, is quite clear from what immediately precedes it. LEWIS H. BERENS.

Ilkley, January 15.

YOUR reviewer regrets an appearance of antagonism between himself and any one who has been genuinely endeavouring to improve natural knowledge, but he must point out that a great deal more study is necessary before a busy man like Mr. Berens can adequately inform himself what the present condition of scientific knowledge really is. O. J. L.

THE TOTAL ECLIPSE OF THE SUN.

IT will be some time before the complete results of the observations of last Saturday's eclipse can be made known, but it is extremely satisfactory that all the expeditions to India from this and other countries were favoured with perfect weather for the work. In places where the eclipse could only be partial the weather was not so favourable; for a telegram from Odessa (to the *Standard*) states that the observations of the solar eclipse in Southern Russia were not very successful owing to unfavourable weather. Only a few good photographs were obtained.

From a telegram received at Greenwich from Sohagpoor we learn that one of the official parties sent out by a joint Committee of the Royal Society and Royal Astronomical Society, consisting of the Astronomer Royal, Mr. W. H. M. Christie, and Prof. Turner, of Oxford, who were stationed at that place, were favoured with a perfectly clear sky, and were thus able to carry out completely the programme they had arranged; the same may be said of another official party, under the charge of Mr. Newall, of Cambridge, and Captain Hills, R.E., who were at Palgaon, near Wardha. The plates had not been developed, so it is impossible to say as yet how good the results are. Of Dr. Copeland, of Edinburgh, there is at present no news. As his station lay between those of the observers previously mentioned, it may be presumed that he also experienced a clear sky, and was, doubtless, equally successful.

A later telegram from Sir Norman Lockyer, who was at Viziadurg, on the West Coast, gives the results after developing the plates. It states: "Weather excellent, and all instruments satisfactorily employed with very good results except the integrating spectroscope. The temperature fell about 3° C. during the eclipse. It was not a dark eclipse, and very few stars were seen."

This news is expressed in fuller detail in the subjoined cablegram from Sir Norman Lockyer to the *Morning Post*:—

"The total eclipse of the sun was successfully observed at our Viziadurg station in the most perfect weather yesterday.

"At our station we had the invaluable assistance of one hundred and twenty-five officers, petty officers, and men from her Majesty's ship *Melpomene*, the observers being divided into twenty-one parties.

"As many as sixty photographs of the spectrum were taken, including four sets of ten instantaneous exposures at the beginning and at the end of the total phase.

"Some of these have been already developed, and are found to exhibit changes in the aspect of the chromosphere second by second at each of the four contacts.

"The corona was a very majestic spectacle, and it resembled that of 1896.

"As had been expected with so many sun-spots, there was no equatorial extension of the luminosity.

"A few stars were seen, but the darkness was not of sufficient intensity to necessitate the use of lamps.

"The longest streamer was a polar one, and had a length equal to four apparent diameters of the moon.

"This streamer was altogether a most exquisite structure.

"Mr. Eliot, the Meteorological Reporter to the Indian Government, and Mr. Pedler, of the Calcutta University, were members of our party.

"Mr. Pedler observed arc lines of iron in the lower corona.

"Lord Graham's cinematograph work has proved quite successful.

"The shadow of the moon on the earth was hardly seen in consequence of our atmosphere being too pure.

"The Collector at Ratnagiri and the officials of the Public Works Department attended, and rendered us every possible assistance."

The observations made at Talni by Mr. E. W. Maunder and Mr. C. Thwaites appear to have been very successful. The sky was beautifully clear. The light during the middle of totality was equal to full moon. The following is a statement of the results reported to have been obtained by the observers. The general shape of the sun's corona was like that seen in the eclipses of 1886 and 1896. The corona extended over two diameters from the sun, and its greatest extent was along the sun's equator. Photographs of the corona were obtained by Mrs. Maunder on a scale of four-fifths of an inch to the sun's diameter, and also on a scale of one-tenth of an inch, to get coronal extensions. The spectrum of the corona, chromosphere and prominences was successfully observed with an opera-glass fitted with a direct-vision prism in one of the eye-pieces. The chief coronal line was not seen on one limb of the sun, but extended to a considerable height at the other. The "flash" spectrum was seen both at the beginning and end of totality. Three photographs of the corona were obtained by Mr. Thwaites on a scale of seven-tenths of an inch to the sun's diameter. Mr. Thwaites also secured photographs of the corona on a scale of one-tenth of an inch to the sun's diameter. Good spectrum photographs were obtained by Mr. Evershed, who is also reported to have photographed the spectrum of the "flash" with a prismatic camera.

Observations of the eclipse were also made by a party from the College of Science, Poona, under the direction of Prof. K. D. Naegamvala, and by a party at Jeur, from the Lick Observatory, Mount Hamilton, U.S.A., under the direction of Prof. W. D. Campbell. It is reported that the sky was extremely clear, and that the observations were very successful. The light during the middle of totality is said to have been greater than that of full moon. The general shape of the corona was similar to that observed in 1886 and 1896. The corona extended to a distance of nearly two diameters from the sun, and its greatest extension was observed along the sun's equator.

A telegram from Dumroon states that the photographic observations made by the survey party there were entirely successful.

Seven good pictures of the corona were obtained during totality.

The following telegram was received from the Rev. J. M. Bacon, who was in charge of the British Astronomical Association party at Buxar:—

"On the Ganges weather perfect; observations satis-

factory all round." Mr. Bacon appears to have taken a successful series of photographs with the cinematograph.

Other information received *viâ* New York indicates that the spectroscopic work of Prof. Campbell was also successful.

With such perfect weather, and the numerous powerful instruments utilised, the results of this eclipse expedition will form a unique record. A short account of some of the larger instruments should, therefore, be of interest.

For photographing the corona the Astronomer Royal was provided with a telescope having an object-glass of eight inches diameter, presented to the Royal Observatory some years ago by Sir Henry Thompson. This instrument gave an image of the sun's disc three inches in diameter on a large-sized photographic plate; the plates employed were such as would be most likely to show the delicate detail of the cloud-like structure close to the sun's limb.

Besides the photographs of the corona, Mr. Christie's photographs of the sun and moon, before and after totality, will, no doubt, be of much value to the theory of the lunar motion.

Another large telescope for photographing the corona was Dr. Copeland's 40-foot coronagraph, fixed up on trestles and directed to the sun, the required movement during totality being secured by a correct motion of the plate. The diameter of the sun's image given by this telescope is 4 inches.

For spectroscopic observations, the prismatic cameras with Sir Norman Lockyer's party were the most powerful. Never before during an eclipse have spectroscopes with so large dispersion and aperture been used. The 6-inch prismatic camera used by Mr. Fowler had two large prisms of 45°, instead of the one prism with which the results of 1893 were obtained, the dispersion being thus nearly doubled (Fig. 1). This added power will tell in many ways. By drawing out the spectrum into a band of twice the length the accuracy of measurement will be greatly increased. Further, remembering that the sky was slightly hazy in 1893, when eight coronal rings were photographed, and that the use of a still greater dispersion, by spreading out the continuous spectrum of the corona, will increase the chances of registering the fainter coronal rings, it is not too much to hope that the photographs taken during the eclipse will add much to our knowledge of the chemical nature of the corona.

A 9-inch prismatic camera, in charge of Dr. W. J. S. Lockyer, although of larger aperture than the 6-inch prismatic camera, had only one prism of 45°, giving a slightly greater dispersion than the 6-inch with one prism.

Each of these prismatic cameras was used in conjunction with a siderostat, and pointed to the reflecting mirror in such a way that the arcs of the chromospheric spectrum at the beginning and end of totality were at right angles to the dispersion. The accompanying illustration (Fig. 2) shows the 9-inch prismatic camera in this position.

Fig 1.—Prisms of the 6-inch Prismatic Camera.

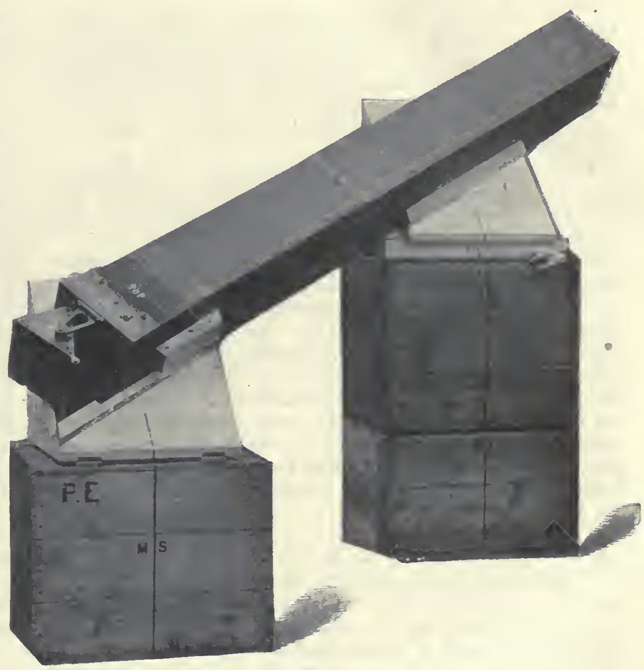

Fig. 2.—9-in. Prismatic Camera in position for the Eclipse.

Besides the prismatic cameras the eclipse camp at Viziadurg was equipped with other instruments for making a complete set of observations, and by the help of the officers, petty officers, and men from H.M.S. *Melpomene*, the whole of the instruments, including the coronagraph, with coelostat, integrating spectroscope, and other spectroscopes for visual work, have been used. Having previously been trained for all kinds of observations, these efficient volunteers have also made disc observations and drawings of the corona, and observed the effects of the eclipse on temperature, wind, landscape, and other natural phenomena.

The great interest taken in the eclipse in India

paved the way for all parties to make their observations and erect their instruments with almost as much ease and facility as if they had been at home. The following letter from Sir Norman Lockyer to the *Morning Post*, on the "Preparations for the Expedition," shows that the Government of India rendered very valuable assistance to all the eclipse parties; and astronomers may well congratulate themselves upon the interest thus officially manifested in their work.

PREPARATIONS FOR THE EXPEDITION.

"On arriving at Port Said I received an important letter and enclosure from Mr. John Eliot, C.S.I., F.R.S., the Meteorological Reporter to the Government of India, who has been unceasing in his labours to further the coming observations. From these documents the final arrangements made by the Government of India may be gathered, and it must be acknowledged that they have been most admirably thought out, and are altogether such as should give the greatest amount of satisfaction to the world of science.

"The long thin line of totality, extending from Viziadurg to the Himalayas, will have, it appears, at least seven parties coming from England extended along it; three official parties and four parties consisting of members of the British Astronomical Association. The local assistance rendered by the Government of India will take the following shapes:

"(1) Accommodation for the observers and their assistants. If bungalows are not available, tents and huts will be erected, and will be available at once on arrival of the parties.

"(2) Messing arrangements, which will also be made before the arrival of the parties.

"(3) Ample supply of materials — bricks, Portland cement, planks, huts, &c.—for the erection of stands, platforms, &c., for the instruments, and of the sheds, which will probably be found necessary for the protection of the instruments. The materials will be arranged for beforehand, but the actual work will have to be done under the superintendence of the heads of the observing parties. Hence a Public Works Department subordinate, with a sufficient number of masons and carpenters, will be deputed for the purpose.

"(4) Portable dark rooms with supply of ordinary photographic materials for developing plates, &c.

"(5) Arrangements for protecting the instruments, &c., and also the observers from the intrusion of natives.

"(6) As many of the arrangements will have to be made beforehand, a European officer of sufficient standing will be appointed to carry out all that is required, and will be given full authority to make the necessary arrangements with the district officers, and be authorised to obtain the services (1) of a Public Works Department subordinate and workmen, (2) of a sufficient number of guards or policemen."

The latter clause of Mr. Eliot's letter appears to have been taken advantage of at most of the eclipse stations, so that in no instance have the observations suffered from the natives, either by the lighting of fires, thereby causing clouds of smoke, or any other interference.

With such a list of successes we may safely say that this eclipse, as befitting the last one of the century, has surpassed all previous records; but unlike many eclipses at the beginning of the century, it cannot be truly said that the event of Saturday was over at the end of the two minutes of totality. To many the eclipse has yet to begin, and will last for many months, during which time each line in the spectrum, each streamer of the corona, each prominence on the sun, will be analysed, little by little, to discover if we have similar streamers in other coronas, or identical lines in our laboratories. It may be confidently expected that the results obtained on Saturday will enable us to solve some of the enigmas of solar phenomena and constitution.

THE FORTHCOMING BRISTOL MEETING OF THE BRITISH ASSOCIATION.

A SUCCESSFUL conversazione was given on Thursday last, in the Victoria Rooms, Clifton, by the Mayor and Mayoress of Bristol (Sir Robert and Lady Symes) and the Local Executive Committee, with the object of stimulating interest in the approaching meeting of the British Association, on September 7, in Bristol. A programme of music by the Royal Artillery (Mounted) Band was arranged and admirably carried out. The Mayor, in a short and effective speech, bade a hearty welcome to his guests, among whom were the President-elect (Sir William Crookes, F.R.S.), the Mayors of Bath, Gloucester, Wells, and the Bishop of Bristol, together with many of the most influential Bristol citizens.

The local secretaries (Mr. Arthur Lee and Dr. Bertram Rogers), together with the local treasurer (Mr. J. W. Arrowsmith), aided by an influential and representative Executive Committee, have been for some time active in making preliminary arrangements for the meeting. The Victoria Rooms, Clifton, will be secured for the reception rooms and offices, the public lectures will be given in the large Colston Hall, and rooms for sectional meetings have been placed at the disposal of the Committee by the Museum Committee of the Corporation, the Council of University College, the Society of Merchant Venturers, the Charity Trustees, and the Bishop of Clifton. Other suitable rooms will be secured. It is proposed to arrange an exhibition of pictures in the Drill Hall, where a military band will play during the afternoons after the sectional meetings. Arrangements are also in progress for a biological exhibit at the Zoological Gardens in Clifton, in which Mr. E. J. Lowe, F.R.S., Dr. Harrison and Prof. Lloyd-Morgan are taking an active interest. It is hoped that the authorities of the Marine Biological Association will be able to show living marine organisms from their station at Plymouth. A fuller account of these arrangements will be communicated to NATURE when they are further advanced.

The excursions promise to be both varied and interesting. As at present projected, they include Bath, where the Mayor and citizens will entertain the visitors; Tortworth, where Lord Ducie will entertain a small party of geologists, and afford them special opportunities of examining the Silurian beds in that neighbourhood; Aust Cliff, with its fine exposure of Keuper, Rhætic, and the lowest beds of the Lias; Stanton Drew, with its megalithic remains, the Cheddar Cliffs and Caves, the sources of the Bristol water supply, the Severn Tunnel, Cadbury Camp, Swindon, Avonmouth, Wells and Glastonbury, where the Mayor of Wells, the Dean and Chapter, and residents will entertain the visitors to lunch, and the Mayor of Glastonbury will provide tea in the old Abbot's Kitchen. Other excursions to Salisbury and Stonehenge, Nailsworth and Stroud, Longleat, and Raglan Castle are under discussion.

The handbook is in active preparation, and its several sections have been placed in the hands of local authorities on the various subjects with which it deals.

It would seem, therefore, that the meeting at Bristol bids fair to be an interesting one, and that every effort will be made to render it also a successful one.

THE REORGANISATION OF THE UNIVERSITY OF LONDON.

THE influential deputation which was received by the Duke of Devonshire at the Privy Council Office on Monday will serve to remind the Government that the scheme for the reconstruction of the University of London as a teaching body has the support of the leaders in all branches of learning. The deputation was thoroughly representative, and its constitution shows the strength of the plea for a measure of educational reform of pressing importance.

The deputation was introduced by the Vice-Chancellor of the University of London (Sir H. E. Roscoe), and included Prof. Michael Foster (representing science), the President of the Royal College of Physicians (Sir Samuel Wilks), the President of the Royal College of Surgeons (Sir William MacCormac), Dr. Frederick Taylor (chairman of the delegates of medical schools), Lord Reay, Principal Rendall (of Liverpool University College), Dr. Crosby (City Corporation), Mr. Sidney Webb (chairman of the Technical Education Committee of the London County Council), Mr. Ralph Palmer (City Guilds), Mr. Warren (President of Magdalen), Sir Wolfe Barry (President of the Institute of Civil Engineers), Mr. Cozens-Hardy, M.P. (chairman of the General Council of the Bar), Sir A. Rollit, M.P., Sir Joshua Fitch, Mr. Anstey, Mr. Haldane, M.P., Mr. Frank Heath (Assistant Registrar of the University of London), and others.

The Duke of Devonshire's sympathy with the objects of the deputation is known to all who are interested in higher education in London; and though the reply he gave to the deputation was cautiously expressed, it is sufficient to justify us in believing that the Government will give prominence in the next Session to the scheme for the reorganisation of the University. The Duke of Devonshire pointed out that the Government did not need to be convinced as to the importance of the question, and that there are no political obstacles in the way; but the effect of the meeting on Monday will be to furnish the Ministry with additional force in urging upon Parliament the expediency of giving such moderate provision of time as may be necessary to overcome the small amount of opposition which still exists to the Bill for the reconstruction of the University.

With regard to the question whether the Senate of the University of London should ask for a new charter, which would carry out the objects required without the interposition of Parliament, or the appointment of a Royal Commission, the consensus of opinion is distinctly in favour of proceeding by statutory commission rather than by new charter. It was, perhaps, just as well that the question was raised, for it enabled the deputation to express the conviction of those who are directly interested in the development of the University, that the only practicable solution of the problem lies in procedure by a Statutory Commission Bill. For the sake of learning and the advancement of science, it is devoutly to be hoped that such a Bill will soon pass through both Houses of Parliament. That there are grounds for entertaining the opinion that this desirable settlement of the problem is in sight may be gathered from the subjoined report abridged from the *Times*:—

Sir Henry Roscoe introduced the deputation, and Prof. Michael Foster, Sir S. Wilks, Sir William MacCormac, Dr. F. Taylor, Lord Reay, Dr. Rendall, the President of Magdalen, Dr. Crosby, Mr. Sidney Webb, Mr. Ralph Palmer, and Sir Wolfe Barry, representing a variety of interests, spoke in support of its object. In the course of his reply, the Duke of Devonshire said:—

I wish, in the first place, to express to you, gentlemen, my cordial thanks for the trouble which you have taken in coming here, for the purpose of repeating and confirming the representations which many of you have, in various other ways, already made as to your sense of the great importance of a reconstitution of the London University upon such lines and principles as will render it, not, perhaps, a teaching University of exactly the same character as the older Universities, but as an institution which will be recognised by all who are competent to form an opinion, and all who hold a leading position in scientific knowledge, as a real and genuine teaching University. The assistance which you have rendered to me in coming in such strength to repeat and confirm these representations will be very great. This deputation was not necessary, so far as the Government was concerned, in order to convince them of the importance of the subject. The fact that the Government has already in two Sessions brought forward a Bill to give effect to the recommendations of the Cowper Commission, has shown that they, at all events, have been convinced by that report of the necessity of such a measure. Neither was the deputation required in order to remove any political obstacles to the passing of such a measure. Politics, I am happy to say, political differences have never entered into this question at all, and a great many members of the present Opposition are as fully committed to the principle of this Bill as the members of the Government themselves. The value of this deputation in my opinion consists in the support which it will give to me in urging upon my colleagues, and which it will give to them in urging upon Parliament, the importance which is attached to the question by almost the whole of those in any way connected with any of the teaching institutions of this great metropolis, and in urging upon them the expediency and the necessity of making such moderate provision of Parliamentary time as may be necessary to remove or overcome the small amount of opposition which still exists as regards the measure. I have, however, little doubt that the more fully I can convince my colleagues of your resolute and determined attitude upon this question, the smaller will be the actual sacrifice of Parliamentary time which will be demanded from them. Much, gentlemen, as the delay which has occurred in dealing with this question is to be regretted, it has, I think, been accompanied by one compensating advantage. It is that the discussion and consideration which have been given to the subject during this period of delay have tended in the direction of removing almost the whole of the serious opposition which has ever been entertained to it. This delay has enabled certain concessions to be made by the advocates of the proposal and a compromise to be arrived at, which has, I believe, substantially removed, as I have said, any serious opposition which had to be encountered. The measure as now proposed cannot be regarded as a triumph of any section of opinion or of interests, but will be, I think, properly and rightly regarded as a fair and just compromise of every shade of opinion upon the University question. Due regard has been paid to the strong and conscientious objections—I will not say whether well-founded objections or not—which were felt by a certain number of gentlemen who undertook the defence of the character and reputation of the work which had already been performed by the existing London University, and the gentlemen who undertook the defence of what they considered to be the interest of external students and those who undertook the defence of independent teaching and the rights of the Convocation of the University. So far has the process of compromise and reconciliation of opinion been carried out, that I have heard that it is possible that the view may be urged that such general agreement has been arrived at that the appointment of a statutory commission is no longer required, and that it would be in the power of the Senate of the University of London itself now to frame such a scheme and ask for the grant of such a charter as would carry out all the objects desired without the interposition of Parliament or the appointment of a Royal Commission. That, perhaps, is a suggestion which has not come under the attention of gentlemen present. I observe that it has received no attention or observation to-day. I am not sufficiently acquainted with the details which will be necessary in order to carry out the report of the Cowper Commission to say whether such a suggestion is possible or not. But it would to some extent strengthen my hands in putting aside a course which may possibly be recommended with some plausibility if, before this deputation separates, I could receive the opinion of some gentlemen who are present. I am under the impression that, although upon vital points practical unanimity has to a great extent been arrived at, the details which would require to be elaborated are probably such that great obstacles would be found to arise in any course except

that recommended by the Commission. I should like, however, to receive an expression of opinion that notwithstanding the progress made towards unanimity in this matter, the course recommended by the Commission—the appointment of a statutory commission to frame the future statutes and to reconstitute the University—is the only one to insure the scheme from further delay and perhaps ultimate failure.

Sir H. Roscoe said that the matter had not been formally brought before the Senate, but he should be expressing the view of his colleagues if he said that the question whether this reorganisation was to take place by charter, or, under the recommendation of the Cowper Commission, by a statutory commission had engaged their attention for many years, and that they had come to the conclusion that in consequence of the complexity of the question the difficulty of drawing up in black and white any statement in the form of a charter would be extremely great. The suggestion that the Senate might act under powers as a statutory commission had not been brought before them, and he could say nothing about it. But as between a new charter and a statutory commission the consensus of opinion was in favour of the commission rather than the charter.

Mr. Anstey, as a long-standing member of the Senate and a member of the Cowper Commission, thought that a statutory commission was absolutely essential. The matter had never been presented to the Senate, but the difficulties were insuperable in dealing with the details.

The Duke of Devonshire: The suggestion which may still probably be made is that legislation has become unnecesary when the approach to unanimity is so nearly complete that everything which is required might be done by charter on the motion of the Senate and not under statutory powers. London University under its existing charter possesses powers to alter its statutes and regulations subject to the approval of Convocation, and the suggestion which I understand might be made was that that course might be adopted with a reasonable prospect of success. I understand, however, that Mr. Anstey has expressed the unanimous, or almost unanimous, opinion of those present that that is not the case, and that nothing short of a body armed with statutory powers, such as the proposed commission, would be sufficient.

Sir Joshua Fitch said the question had been amply discussed by the Royal Commission, and their deliverances were unanimous and unanswerable. The difficulty of submitting such a charter to a scattered body like Convocation was too serious for the attempt to be practicable.

Mr. Anstey explained that the unanimity was only on the point that there should be a statutory commission.

After thanking the Duke of Devonshire for his reception of the deputation, the members of it withdrew.

THE FORTHCOMING INTERNATIONAL CONGRESS OF ZOOLOGY.

ENGLISH zoologists ought to learn with satisfaction that the International Congress, which has already met in France, Russia, and Holland, will meet in this country next August. The first Congress took place in Paris at the time of the International Exhibition in 1889. For some reason—perhaps the cholera—the second meeting, held in Moscow in 1892, was not largely attended. The third meeting at Leyden, in 1895, was attended by 173 zoologists with their wives and other members of their families.

It is to be hoped and expected that the meeting at Cambridge will be still more largely attended, and there is every reason to hope that the German element, which has not been conspicuous at previous meetings, will be better represented in this country.

We have already stated that, unfortunately, owing to the condition of his health and his numerous and arduous official duties, Sir William Flower, K.C.B., F.R.S., who was naturally elected President for the fourth Congress at the meeting in Leyden, has felt constrained to resign his post. To the general satisfaction of zoologists the Right Hon. Sir John Lubbock, Bart., F.R.S., was appointed in his place. At Cambridge a strong Committee has been formed, which is now actively engaged making the necessary preparations for the coming together of zoologists, and for their suitable reception and entertainment.

It may be mentioned by the way that August 23 and the town of Cambridge are the date and place of meeting, not only of zoologists, but also of physiologists, who intend to hold a Congress in the same week.

The Executive Committee of the Congress, selected from the General Committee, has somewhat varied the mode of invitation which obtained at previous Congresses. The invitation to the Congress is signed solely by English zoologists, and, on the whole, the list may be said to be a representative one, although it is to be regretted that Mr. A. R. Wallace and Prof. Allman have felt the weight of years too heavy to justify them in taking any part in this Congress. Our fellow zoologists in the Colonies and India have been invited to join the General Committee, and steps are being taken to invite the Indian and Colonial Governments to send delegates to the Congress. The more eminent foreign zoologists have been invited to form the Committee of Patronage which is always established at these Congresses, and we are glad to hear that already more than sixty have agreed to become members of this Committee, and a number have declared their intention of being present at the meeting if they possibly can. Among these may be mentioned Prof. Milne-Edwards (of Paris), Prof. Hubrecht (of Utrecht), and Prof. Kowalevsky (of St. Petersburg).

Visitors to earlier Congresses always brought away an account of generous hospitality, and there can be no doubt that our foreign friends will be charmed at meeting in a place so strange and interesting to them as an English University town. If English zoologists are to keep up the high standard of previous Congresses, from the point of view of hospitality, it will be necessary for them to contribute handsomely to the funds of the Congress. It may be mentioned that Mr. P. L. Sclater, F.R.S., and Prof. Hickson, F.R.S., are the Treasurers for this meeting.

The Zoological Society has placed its house at the disposal of the Executive Committee, and all letters to the Treasurers or the Secretaries should be addressed to them at No. 3 Hanover Square.

We are requested by the Secretaries to say that they have taken every means in their power to send invitations and notices to all zoologists whom they have been able to reach; but Secretaries are not infallible, and the Post Office itself has been known to fail in its duties before now. Any zoologist therefore, whether foreign or English, who has not yet received notices with regard to the Congress, should put himself into communication with the Secretaries at the above address.

MODERN VIEWS OF THE RAINBOW.[1]

DESCARTES'S theory of the rainbow, which is still found in all optical text-books, is hardly even a rough approximation to the true theory. It does not fully explain the ordinary bows, and fails entirely as regards the "spurious bows," improperly so called. Any close observer will, under favourable conditions, notice certain colours on the inside edge of the primary bow which are not consistent with the simple series of spectrum colours demanded by the venerable theory which may be said to mark the birth of modern science. These additional colours, chiefly red and green, recall the colours seen in Newton's rings at some distance from the centre, and at once suggest a similar origin. In a paper on "the intensity of light in the neighbourhood of a caustic" (*Trans. Camb. Phil. Soc.*, 6, 1838, and 8, 1848), Airy has laid the foundation of an adequate theory of the rainbow which is gradually being worked out. With

[1] See a paper by J. M. Pernter, *Wien. Ber.*, 106, Part 2, a, 1897, and Abstracts of the Physical Society, No. 86.

a considerable amount of patience, Mr. J. M. Pernter has calculated the tints and the angular deviations of the rainbow colours for various sizes of rain-drops, and has devised experiments in support of his deductions. A parallel beam of sunlight after reflection and refraction in a spherical rain-drop does not emerge as a parallel beam, or as a bunch of parallel beams of various colours, but as a series of caustics of a somewhat complicated nature, in which the divergence of the colours, and hence their distinctness, separation, or coincidence depend upon the ratio of the radius of the drop to the wave-length of the light. The influence of size is very formidable in the smaller drops, say of 0·01 mm. radius. This would be a very fine spray. The actual size of rain-drops is supposed to vary between 0·1 mm. and 2·6 mm., but the heavy drops of tropical rains are said to attain diameters of 3·4 mm. Their size may be estimated by catching up and weighing a definite number, or by the more difficult method of diffraction. The tables drawn up by Pernter consider drops of twelve different sizes between 0·005 and 1 mm. radius. In order to determine the resulting colours, Pernter selects eight of Maxwell's twenty-two colour equations, which number he finds sufficiently accurate. The first set of his tables state, for a point source of light, the sequence of colours, their composition in terms of red, green, and violet, the relative intensity (admixture of white, after Abney) and position on the colour triangle of each shade for various deviations between 42° 20′ and 36°. These tables are then verified by experiments with cylindrical streams of drops, according to Babinet's method. With 1 mm. drops, Pernter observed red, orange-yellow, green, violet, blue' second violet, and then twenty-four secondaries or spurious colours, chiefly pinkish-violet and green or blue; after the twelfth violet came a whitish band, and then a reversal in the sequence of the colours. The 0·5 mm. drops gave 11 bows with 40 shades. The outer bow and its secondaries were also observed. Verifications in nature are hardly possible, as we cannot measure simultaneously the angles and the size of the drops producing the bow; it is striking, however, that so very few angular measures are extant.

The white or pale rainbows (fog or mist bows) around moon and sun may appear pale owing to (1) the feeble intensity of the light, (2) the uneven size of the drops, and (3) the mixture of colours. The first cause is probably a real one; the second Pernter is inclined to reject, since the accompanying, often well-defined features such as "glories," Brocken spectra, &c., and also his own tests require homogeneous conditions. As regards the third, Abney has proved that all colours of any shade disappear on being diluted with 75 parts of white, and Pernter's tables show that such cases may well occur. Further, Airy's theory renders white bands possible for all sizes of drops, and necessary for radii below 25 μ. As a stream of water of such fineness cannot be maintained, Pernter produced a mist spray by fixing a 0·5 mm. glass tube in a lead pipe connected with the Innsbruck water mains (pressure 5 atmospheres), and directing the jet against a metallic plate; the size of drops was derived from measurements of diffraction rings. Drops of radius 5 μ gave a yellow margin at 41° 59′, white between 41° 8′ and 38° 27′, and then blue to 37° 41′; larger drops were more difficult to manage. From measurements of fog-bows on Ben Nevis, J. McConnell had in 1890 already calculated the sizes of the respective drops. But some of these observations speak of a red outer margin, for which Pernter looked in vain, and which his calculations do not indicate; Crailheim-Gyllensköld (Swedish North Pole expedition, 1882) also describes the margin as of ochre colour. The classical white bows of Bouguer (1744) and of Scoresby (1821), however, do not fit into the theory at all, and were probably due, as the observers remarked, to ice-needles.

The general conclusions are interesting to meteorologists. The greater the drops, the more secondaries (spurious bows). A chief bow of intense pink and green (hardly any blue) indicates drops of diameters ranging from 1 to 2 mm.; intense red always speaks for big drops. Secondaries of green and violet (the blue is masked by contrast) without yellow, immediately joining the chief bow, correspond to drops of 0·5 mm., while five and more secondaries without white and without breaks mark drops of 0·1 mm. A partly white bow is produced by drops of 0·06 mm., and when the drops are still smaller, a real white bow with orange-yellow and blue margins is the result. The net result of these elaborate investigations will be to add a new interest to a natural phenomenon already endowed with many associations of magic and beauty.

EDUARD LINDEMANN AND OSCAR STUMPE.

THE last days of the old year witnessed the removal by death of two astronomers who have rendered valuable services in the respective positions in which they were situated, though not occupying prominent places in the history of the science. Both are mentioned by the authorities under whom they served with the utmost respect, and their loss is acknowledged with profound regret.

Dr. Eduard Lindemann, who died suddenly on December 21, was born in Nishni-Novgorod in 1842, and pursued his scientific studies in the Universities of Kasan and Dorpat. The latter University he left in 1868 to enter the observatory of Pulkova, wherein he filled the office of scientific secretary. In this capacity he had the management of the library, and the preparation of the second part of the "Librorum in Bibliotheca Speculæ Pulkovensis contentorum Catalogus systematicus" was entrusted to him, and very admirably did he fulfil the trust. The duties of his office did not permit him to take a great part in the astronomical observations there carried on; but his tastes led him to take great interest in the Zollner photometer, and the series of careful measures which he made with that instrument have led to his being regarded as an authority in its use. His paper on the "Brilliancy of Bessel's Stars in the Pleiades," published in tome xxxii. of the *Mem. de l'Acad. Imp. des Sci. de S. Petersbourg*, is well known, and he has further used his measures to determine the scale of magnitude employed in the Bonn Durchmusterung.

The second astronomer whose death (at the early age of thirty-five) we have regretfully to mention is Dr. Oscar Stumpe, well known for his contribution on the motion of the solar system. Dr. Stumpe's early life appears to have been one of great hardship and a severe struggle against adverse circumstances. When ten years old he lost his father, but, in face of all difficulties, he determined to win his way to the Berlin University as a student of science. This he accomplished in 1883, though he had had occasionally in previous years to interchange the parts of student and teacher in order to obtain a livelihood and be enabled to continue his career. Even at Berlin, his studies of mathematics and astronomy were interrupted by his duties as a shorthand writer in the Government and Law Courts. From Berlin he went to Bonn, and became a teacher in a private institution. Here he appears to have prepared the heavy calculations which he afterwards incorporated in his inaugural dissertation on the Solar Motion. In this work, Dr. Stumpe based his computations on 1054 stars, whose annual proper motion exceeded 0″·16 in the arc of a great circle. The peculiar feature in the treatment was the introduction of a term

depending upon a supposed orbital motion of the stars in the plane of the Milky Way. This term did not appear, however, to have a real existence. The stars were divided into four groups depending upon the amount of the annual proper motion, and the four solutions gave very accordant results in R.A. for the position of the apex of the solar system. The declination appeared less certain, but great confidence has been attached to the results of this particular investigation. Dr. Stumpe's talents as a computer have been generally recognised. He took some share in the calculations of the star places in the Bonn Zone Catalogue under Prof. Deichmuller, and afterwards, on repairing to Berlin in 1891, he was engaged in the preparation of the Zone Catalogue 15°—20° declination. Since that time he has assisted Dr. Auwers in the many researches with which that astronomer has been connected, and who loses in him an able co-operator and a devoted assistant.

NOTES.

AT the ordinary meeting of the Royal Society last week, Sir Nathaniel Lindley, Master of the Rolls, was balloted for and elected a Fellow under the special clause in the statutes which permits the admission of members of the Privy Council; and similarly, to-day it is proposed to ballot for Sir Herbert E. Maxwell. It may be recalled that Sir N. Lindley is a son of the late Dr. John Lindley, the famous botanist.

THE original lists of the subscribers to the Indian Section of the Pasteur International Memorial (British Division) have just been received from Surgeon-Major-General Cleghorn. On glancing down the columns where the profession of the donor is given, the first thing which strikes us is the very varied character of the generous contributors to this fund. We find, for example, members of the Indian Civil Service, the Indian Medical Service, officials in the opium department, in the salt department, forest officers and a number of native forest students, members of the legal profession (including a number of native pleaders), merchants (one of whom mentions having been a patient of Pasteur's), chaplains, medical and other missionaries, numbers of jailors and warders, an indigo planter, locomotive superintendents and assistants, the principal of a theological seminary at Insein in Burma, the superintendent of a Government lunatic asylum, civil apothecaries, bankers, revenue clerks, collectors and magistrates, numbers of "private gentlemen" (Indian), the Governor of Madras, the head-master of a missionary school, &c.; whilst the Army in India has also furnished a large contingent of subscribers. In one district we find a note saying that the inhabitants "are not willing to subscribe to the Pasteur Memorial, but will willingly subscribe towards the Pasteur Institute." The manner in which the fund has been supported in India not only reflects the greatest credit upon the subscribers, but also upon those who have so efficiently organised its collection.

AT the Royal Institution last week, Prof. E. Ray Lankester, F.R.S., in commencing his course of eleven lectures on "The Simplest Living Things," remarked that though of late years it had become the custom to use the term physiology as meaning the study of the chemical and physical properties of living things in contradistinction to the study of their structure, yet fifty years years ago it denoted their general study, and the Fullerian Professorship of Physiology—the chair to which Prof. Lankester has just been appointed—was intended for the furtherance of physiology in the broad sense now given to the term biology. It is proposed in a subsequent course to continue the consideration of the simplest living things by a detailed examination of the structure and activities of the different kinds bacteria, and to give an outline of the science of bacteriology.

MR. CORNELIUS N. HOAGLAND has given to the Hoagland Biological Laboratory of Brooklyn a mortgage for 24,000 dollars.

ELECTRICITY is to be substituted for steam as the motive power of the elevated railroad system of New York City. Contracts for the new equipment have just been signed.

M. J. O. E. PERRIER, member of the section of anatomy and zoology of the Paris Academy of Sciences, has been elected *membre libre* of the Academy of Medicine, in succession to Dr. Magitot.

THE Council of the Sanitary Institute have accepted an invitation from the Lord Mayor and City Council of Birmingham to hold its seventeenth congress and exhibition in that city in September next.

AFTER sixteen years as professor of geography at the Royal University of Turin, Prof. Guido Cora has resigned his charge, in order to devote himself entirely to scientific researches in geography and related sciences. He has transferred his residence (and the direction of his periodical *Cosmos*) to Rome (Via Goito, 2).

THE death is announced of M. Bazin, the French engineer whose "roller-boat" has on several occasions been referred to in these columns.

THE unpublished manuscripts of the late Prof. Julius Sachs, of Würzburg, have, in accordance with his wish, been placed in the hands of Prof. Noll, of Brünn.

PROF. A. S. KIMBALL, for many years professor of physics in the Worcester Polytechnic Institute, and the author of a number of important papers on the subject of friction between sliding surfaces, as well as of other original contributions to physical science, died on December 2, 1897, after a long illness.

DR. DAWSON WILLIAMS, assistant editor of the *British Medical Journal*, who has been connected with the editorial department of the *Journal* for seventeen years, and has on many occasions discharged the duties of acting editor, has been appointed editor in succession to the late Mr. Ernest Hart. Mr. C. Louis Taylor, who has been sub-editor for the last eleven years, has been appointed assistant editor.

A CURIOUS incident in natural history is related by a correspondent of the *Aberdeen Journal* (January 22). While ferreting rabbits on the bank of a small stream, Mr. J. Robson, a gamekeeper who has for about sixty years been out with rod and gun between the Derwent and the Thurso rivers, states that on the ferret coming out of a hole and running up the edge of the stream, a trout leaped out of the water and fell on the gravel in front of the ferret. The ferret attacked the fish, and after considerable difficulty succeeded in capturing it. Mr. Robson sententiously adds: "I then creeled them both."

THE fifty-first annual general meeting of the Institution of Mechanical Engineers will be held in the rooms of the Institution of Civil Engineers, Westminster, on Thursday and Friday, February 10 and 11. The retiring president, Mr. E. Windsor Richards, will induct into the chair the president-elect, Mr. Samuel W. Johnson. The paper on "Mechanical Features of Electric Traction," by Mr. Philip Dawson, read at the last meeting, will be further discussed, and the following papers will be read and discussed, as far as time permits:—First Report to the Gas Engine Research Committee: description of apparatus and methods and preliminary results, by Prof. F. W. Burstall; steam laundry machinery, by Mr. Sidney Tebbutt.

THE death is announced from Halle of Dr. Ernst Ludwig Taschenberg, well known as an entomologist. Born in 1818, he was appointed in 1856 Director of the Zoological Museum at Halle. His entomological studies, begun after his connection

with the Museum, were devoted at first to the hymenopterous fauna of Middle Europe, on which his chief work was "Die Hymenopteren Deutschlands" (1866). These writings were largely compendiums of existing information, and his chief claim to recollection rests on the production of several valuable handbooks on the injurious insects of Germany, such as his "Entomologie für Gärtner und Gartenfreunde" (1871); "Forstwirthschaftliche Insektenkunde" (1874); "Praktische Insektenkunde" (1879-80); and "Die Insekten nach ihrem Schaden und Nutzen" (1882). His "Praktischen Insektenkunde," in particular, published in five parts, is an excellent account of the characters, bionomics and economy of all the more important injurious insects of Middle Europe, arranged according to systematic position, and not, as is generally the case, in relation to the nature of the damage they occasion. In the absence of any satisfactory general text-book on the subject published in this country, this work is indispensable to any serious study of injurious insects in Great Britain, as well as in Germany. Save for a single paper on Hymenoptera, which appeared in 1891, Dr. Taschenberg published nothing on entomology during the past fifteen years.

FOR some time past the weather has been unusually mild for the time of year, and the returns received by the Meteorological Office show that higher temperatures have occurred in parts of the British Islands during the past week than in any January during the last twenty-five years at least. At Wick a temperature of 60° was recorded on the 19th, which is 3° higher than any previous record in this month, and in other parts of Scotland almost equally high readings were observed. The *Weekly Weather Report* of the 22nd inst. showed that the temperature was 7° or 8° above the mean in all districts except the north of Scotland, where it was 5° above the average.

THE current-intensity of a lightning flash is difficult to determine, since we cannot well send it through a galvanometer and determine the magnetic field produced by it. But there are other lines along which we can approach the problem, as has recently been indicated by F. Pockels in the jubilee number of *Wiedemann's Annalen*. It has been noticed that some rocks found on the surface of the earth exhibit a magnetisation which is quite out of keeping with the earth's ordinary magnetism. The probability is at once suggested that their magnetisation may be due to lightning discharges in the neighbourhood. Herr Pockels cut some rods out of the basalt of the Winterberg in Saxony which showed such irregular magnetism, and found on testing them that the permanent magnetism they possessed could only be imparted to them by a current of at least 2900 amperes passing along the surface of the rock. If the discharge did not pass there, it must have been a good deal stronger, so that this is only a minimum value. Later on, he cut some basalt in the neighbourhood of a tree which had been damaged by lightning, a circumstance which gave him some clue to the distance at which the current passed. The value then obtained for the current strength of the lightning was 6500 amperes.

M. ARMAND VIRÉ contributes to the *Revue générale des Sciences* for December 30, a highly interesting paper on subterranean fauna, which he has made the subject of extended study, both in the catacombs of Paris and in the large caves of the Jura, the Pyrenees, and the central plateau of France. A number of illustrations are given of the cæcal forms of arthropods and crustacea discovered by M. Viré, several of which have been described as new species, though the author has endeavoured to refer them to existing forms which have become modified by environment. Most of these cave inhabitants are characterised by the extraordinary development of their tactile and auditory organs, their antennæ, legs, and even their bodies being covered with fine hairs highly sensitive to the slightest disturbance. In searching for transitional types, M. Viré has met with a fair measure of success. In the case of *Asellus aquaticus*, both normal and subterranean forms exist, the latter presenting marked differences in their antennules. The author considers that the subterranean genus of beetles, *Anophthalmus*, is probably referable to *Trechus*, and that the new species, *Niphargus virei*, is possibly a modified form of *Gammarus*. Finally, M. Viré suggests the desirability of an extended series of experiments on these transitional forms, with a view of ascertaining how far they tend to revert to the normal types on being restored to light.

THE transformation of Röntgen rays by metals forms the subject of a note contributed to the Société Française de Physique, by M. G. Sagnac (*Bulletin*, No. 106). When such rays are incident on a metal surface they are not perceptibly reflected, but the superficial layer transforms them into secondary rays capable of producing photographic impressions, of exciting fluorescent screens, or of discharging electrification. These secondary rays differ from ordinary Röntgen rays in that they are freely absorbed by aluminium, the absorption giving rise to a further kind of tertiary rays, still more readily absorbed by aluminium. M. Sagnac suggests that the secondary and tertiary rays may be intermediate between true Röntgen and Lénard rays.

AN important memoir on the magnetic properties of tempered steel has been communicated to the Société d'Encouragement pour l'Industrie Nationale, for publication in their *Bulletin*. The authoress, Madame Sklodowska Curie, discusses which are the best kinds of steel for the construction of permanent magnets. In the first series of experiments, bars and occasionally rings of steel were heated in an electric furnace the spiral current of which at the same time furnished the magnetic field. It was found that steel does not take the temper unless heated to a temperature superior to that at which its magnetic properties change. Among various steels, those containing 1·2 per cent. of carbon were found best suited for the construction of permanent magnets. Madame Sklodowska Curie has also considered the presence of different metals in steel. While these do not usually modify the residual magnetisation, they often considerably ncrease the coercitive field, *i.e.* the field required to cause demagnetisation; the addition of tungsten or molybdenum furnishing the best steel for magnets. The paper concludes with an examination of the stability of magnetisation in bars, the effect of blows and of variations of temperature being specially considered. The greater the coercitive field the less is the effect of blows; heating to 200° considerably affects good magnetic steel, even a temperature of 100° is detrimental, while the best permanent magnets are made by heating the steel to only 60° and partially demagnetising it after having magnetised it to the point of saturation.

THE *Journal de Physique* for January contains, in addition to abstracts, papers by M. A. Leduc, on the densities, molecular volumes, compressibility, and dilatation of gases at different temperatures and at mean pressures; by M. H. Pellat, on the variation of energy in isothermal transformations considered with special reference to electric energy; by MM. Pellat and Sacerdote, on contact phenomena; and by M. G. Sagnac, on diffraction of plane waves by slits and gratings.

AN atlas of the currents of the Pacific Ocean has just been published by the Hydrographer of the Admiralty from information collated and prepared in the Meteorological Office. This is the third volume of current charts for the great oceans that has recently been issued in the same way, with the view of providing the navigator with the best available information. The sources from which the observations were obtained being (1) logs received in the Meteorological Office, mainly from the Mercantile Marine, from 1854-96; (2) logs and

remark books of H.M. ships from 1830-94. Although charts for each month have been prepared, it has been thought advisable to publish four only, viz. for the representative months January, April, July and October, as the amount of information is still deficient in many places unfrequented by ships. The charts show the average direction of the currents and the maximum and minimum velocity which may be expected. In the case of the Japan Stream, which runs almost uninterruptedly to the north-eastward, the velocity sometimes reaches from seventy to seventy-five miles a day. It is seen that there is generally a south-easterly current down the west coast of North America, and a northerly current along the coast of South America, and that these two streams are deflected near the equator to form the equatorial current.

WE have just received the general report of the operations of the Survey of India Department for the year ending September 30, 1896. The report states that the most interesting and important feature of the year's work is the completion of the telegraphic determination of the difference of longitude between Greenwich and Karachi, undertaken with the view of obtaining a definite value for the longitude of Madras (see p. 284). The tidal observations appear to have been regularly and successfully prosecuted. Self-registering gauges are maintained at thirteen stations, and during the year a new tidal observatory was erected at Suez, while preliminary surveys have been made at Perim, Port Albert Victor, and Porbandar, with the view of adding these places to the list of stations. The error of predicted time of high and low water at those open coast stations which are provided with self-registering gauges did not exceed fifteen minutes in about 65 per cent. of the observed tides, while on about 95 per cent. the predicted height did not differ from the observed by more than eight inches. At the riverain stations, the same amount of accuracy in both time and height was reached in 57 and 60 per cent. respectively, but the time of low water was much less certain than that of high. The bulk of the volume is taken up with details concerning the progress of the various surveys, and the preparation of the results for public use. These surveys, of various kinds, extend over a wide area, and bring home to us the immense amount of work accomplished by the department. Here one may read some details of the delimitation of the frontier between British territory and Afghan, and a few pages further on trace the work of demarcation of the Burma-Siam boundary. The interests of the department are wide enough to embrace, and the machinery sufficiently elastic to produce, either a series of sun pictures or illustrations of the action of cobra poison on the blood.

THE remarkable shark, *Chlamydoselachus anguineus*, whose tricuspid teeth and other structural peculiarities render it unique among recent fishes, has been so rarely obtained that the discovery of a specimen in the Varanger Fjord is a matter of considerable interest. Up to the year 1889 only thirteen specimens of this reanimated Devonian fossil had been secured by naturalists, and all of these came from Japanese waters—the last abode of so many primitive oceanic types. In 1889, however, the Prince of Monaco captured a small *Chlamydoselachus* off Madeira, and now Mr. R. Collett provides a description of an unusually fine and complete specimen caught off the coast of Norway rather more than a year ago. His memoir contains a history of all previous records, and is illustrated by an excellent photograph of the fish taken soon after its capture.

THE reason why spiral growths in nature should sometimes take one direction and sometimes another, is often difficult to determine. Mr. George Wherry recently described a few of these puzzles in nature growth before the Cambridge Medical Society. Referring to shells he pointed out that the ancient whelk, now in fossil form (*Fusus antiquus*) is usually left-handed, while in the present generation of common whelks the shell is always right-handed. Nevertheless, among the right-handed shells there is occasionally found a specimen of a modern whelk of the ancestral type going a contrary curve. What was there at work in the whelk when the soft young creature began life to give it the twist to left or right? and why are the ancient whelks found going the "wrong" way? Similar questions may be asked of other natural torsions. For instance, spiral growth in plant-life is a subject of bewildering interest, and though worked at by so many great observers, from John Hunter to the Darwins and De Candolle and the modern Germans, there are still many phenomena wholly unexplained. The hop and honeysuckle take the form of a left-handed screw; the majority of twining plants, however, twine like a right-handed screw—*i.e.* from the left below to the right above when the plant and its support are looked at from the exterior. A twining plant will make its spiral curves without a support if the terminal be merely steadied by a thread and weight over a pulley so that the apex of the shoot is drawn vertically upwards, but a free horizontally sweeping shoot will make no spiral turns at all. There are also other spiral growths which present many points of interest, and sometimes the value of a twist in a particular direction can be easily understood. Mr. Wherry points out that the horns of the koodoo, for example, are twisted in a right-handed spiral on the left side and a left-handed spiral on the right side. The result is that when the animal rushes through the bush the horns thrown back act as a wedge and drive aside the branches as the koodoo dashes through the thicket. With regard to hoofs and nails, it is astonishing under the influence of moisture and absence of friction how these organs will curve and grow spirally.

THE cause of death by electric shocks has been experimentally investigated by Prof. T. Oliver and Dr. R. A. Bolam, who describe their methods and results in the *British Medical Journal.* The increasing employment of electricity within the last few years has demonstrated, by the accidents to workmen engaged in its generation and distribution, that danger is involved. Two opinions are held as to the cause of death in such cases, viz.: (1) that death is due to failure of the respiratory centre (d'Arsonval); (2) that it is due to sudden arrest of the heart's action. From the appearance presented by the internal organs after death, some physiologists have maintained that death is due to asphyxia. But other evidence suggests that death is not due to failure of the respiratory centre. In the experiments carried out by Prof. Oliver and Dr. Bolam, an alternating current was used, and death appears to have resulted from heart rather than respiratory failure. Whilst in some of the experiments death seemed to be due to contemporaneous cessation of the respiration and heart's action, yet in most there was ample demonstration that the organ first to be arrested was the heart, for breathing was observed to continue rhythmically for a brief period, and then irregularly and feebly before stopping. There is reason to believe that only in the case of very high voltages with currents considerably above the potential usually required to kill the animal is there simultaneous stoppage of heart and respiration. Primary cessation of the heart's beat is, without doubt, the general rule, while under no circumstances did the authors succeed in causing primary arrest of respiration followed by failure of the heart. It follows from this that resuscitation in apparent death from electric shock is made much more difficult than if the fatal result were brought about by respiratory failure. With reference to these experiments, Dr. Lewis Jones calls attention, in the *Electrical Review*, to a similar investigation carried out by him in 1895, using a continuous current.

THE first volume is announced of the new "Flora of the Pyrenees," by the late P. Bubani, edited by Prof. Penzig, of Genoa. It is published by Hoepli, of Milan, and will be followed by three other volumes.

AN amusing instance of the want of observation of the commonest phenomena of nature has come under our notice in a schedule of the "Language of Flowers" issued by a well-known firm of perfumers. The symbol for "assiduous to please" is "sprig of ivy with tendrils"!

DR. A. WAGNER, of Neuhaus am Inn, Bavaria, issues a list of fifty microphotographs at 1 m. and 1 m. 50 each, a reduction on a quantity. The subjects are entirely botanical, and include sections and microscopic organs of Phanerogams and Cryptogams.

DURING February the following science lectures will be given at the Royal Victoria Hall:—February 1, "Insects in a London Back Garden," Mr. F. Enoch. February 8, "The Problem of the Great African Lakes," Mr. J. E. S. Moore. February 15, "Brains," Mr. Hugh de Haviland.

MR. S. B. J. SKERTCHLY has a note, in the "Geological Survey of Queensland," on a plant which he calls the "copper plant," *Polycarpæa spirostyles*, belonging to the Caryophyllaceæ. He finds it always associated with copper lodes, and thinks it may be of use, on this account, from a practical point of view. Analysis shows the ash to contain an appreciable amount of copper.

DR. C. E. BESSEY republishes, in a separate form, his address as retiring president of the Botanical Society of America, entitled "The Phylogeny and Taxonomy of Angiosperms." A modification, to a not very large extent, is proposed of the systems of De Candolle and of Eichler and Prantl, by which it is thought that the phylogenetic relationships of the orders of Monocotyledons and Dicotyledons are more completely indicated.

WE have received the first three numbers of a new serial, the *Circular* of the Royal Botanic Gardens, Ceylon, intended to deal with agricultural, horticultural, and botanical topics, with special reference to the work carried on in the Botanic Garden. The chief subject treated in these numbers is the canker of the cacao tree, its cause, and the possible remedies, including a correspondence on the subject with the authorities at Kew.

MR. J. H. HART, the Superintendent of the Royal Botanic Garden, Trinidad, has commenced, in the *Bulletin of Miscellaneous Information*, the publication of a monograph of the Ferns of the British West Indies and Guiana, prepared by Mr. G. S. Jenman. Vol. iv. part 5 of the *Bulletin*, for January 1898, is entirely occupied by the two genera *Hymenophyllum* and *Trichomanes*, twenty-nine species being described of the former, and forty-two of the latter genus.

A LEAFLET on "The Advantages of Boiling Drinking Water and Milk" has just been published by the National Health Society. It is written by Mrs. Percy Frankland, and is intended for distribution amongst both rich and poor. It contains a brief account of the dangers which may attend the use of contaminated water and milk, and a few simple instructions are given for ensuring the removal of any noxious germs which may be present by the efficient boiling of these liquids. Copies for distribution may be obtained of the Secretary of the Society, 53 Berners Street, London, W.

THE additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythrus*) from South-East Africa, presented by Miss Rogers; a Smooth-headed Capuchin (*Cebus monachus*) from South-east Brazil, presented by Mr. W. S. Jay; a Chinese Goose (*Anser cygnoides*) from China, presented by the Rev. E. Hensley; a Beccaris Cassowary (*Casuarius beccarii*) from New Guinea, deposited.

IN the notice of Mr. Dodgson, the words "symbolically developing and popularising" should be inserted before "the study" in the seventh line from the end (p. 280).

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY:—

Feb. 3. 18h. 43m. to 19h. 10m. δ Geminorum (mag. 3·7) occulted by the moon.
5. 17h. 34m. Near approach of o' Cancri to the moon.
6. Pallas 1° N. of τ Eridani.
9. 10h. 13m. Minimum of β Persei (Algol).
11. 6h. Mercury 1' N. of Mars.
11. 17h. 26m. to 17h. 54m. 89 Virginis (mag. 5·2) occulted by the moon.
12. 7h. 2m. Minimum of β Persei (Algol).
13. 19h. 33m. to 20h. 37m. *b* Scorpii (mag. 4·8) occulted by the moon.
14. 10h. 23m. Moon in conjunction with α Scorpii (Antares).
14. Illuminated portion of Venus = 1·000.
,, ,, Mars = 0·981.
14. 17h. Saturn in conjunction with moon. Saturn 5° 30' N.
15. Venus 1½° S. of the sun.
23. 8h. 52m. to 9h. 11m. Jupiter with only one visible satellite.

THEORY OF PERIODIC COMETS.—We have already called attention in this column (September 16, p. 473) to the recent work of M. Callandreau on the subject of disaggregation of cometary matter, and pointed out the lines he has followed in his research. In the *Annales de l'Observatoire de Paris, Memoires*, t. xxiii., he has collected the results of his recent work, and examined to what extent the theory is supported by recent observations. The circumstances favourable for disruption are—close approach to Jupiter, small relative velocity, and small excentricity of orbit. The question is, therefore, to what extent do the elements of comets which have given evidence of disintegration exhibit these peculiarities. It must be remembered, that it is only since the comet of 1882 was seen to be accompanied by faint nebulous matter that the neighbourhood of a comet has been regularly explored to detect the presence of companions. The most typical case yet noticed is that of the comet of 1889 V., which was very numerously attended, and of which it has been established that the orbit of at least one of the companions cuts the orbit of the principal comet near its aphelion. Since this comet, as Chandler has shown, made an approach to Jupiter in 1886, it seems likely that the disruption took place then, owing to the influence of that planet, since the conditions indicated as favourable to the theory are all present in this instance. The existence of the two distinct comets of Wolf and Barnard (1892 V.) can with probability be traced to the action of Jupiter, but the epoch at which the approach to the planet occurred cannot be decided.

The famous instance of Biela is inconclusive. A general investigation of the distance between the two nuclei shows that this is greatest about perihelion, and least at, or near, aphelion. The difficulty of identifying the two nuclei led Prof. Hubbard to make two hypotheses in his calculations, and he preferred that which gave the minimum distance between the two nuclei. But M. Callandreau shows that adopting the second hypothesis, which, though rejected by Hubbard, is by no means excluded by the result of his researches, the division of the comet into two parts would take place in Heliocentric Longitude 266°, while the longitude of the point of closest approach of the orbit of Jupiter and the comet is 268°.

The suggestion that a family of comets with aphelia near the orbit of Jupiter and with periods approximately half that of the planet, should be introduced into the solar system by the action of Jupiter, is not without its objections, based on the theory of probabilities; but the multiplication of comets by disruption is free from this objection, and would also tend to explain the faintness which is a feature of this class of comets.

PHOTOGRAPHIC MAGNITUDES.—In *Circular* No. 22, issued from the Harvard College Observatory by Prof. Pickering, the question of photographic magnitudes of stars is considered. It is pointed out that it is a matter of great importance to know how much the relative brightness of star images will vary on different plates, or on different portions of the same plate. It is especially important to determine the amount of this error, since it is not easily eliminated and has been supposed to be large by some persons not familiar with stellar photographs. A moment's investigation of photographs of the same portion of the sky shows that this source of error is small, so small

that it is not readily determined by direct measurement. The uniformity of different portions of the film is shown by allowing the stars to trail over the plate. A much more delicate test was found in the discussion of a series of measures of the variables discovered by Prof. Bailey in the cluster Messier 5. Sixty-three of these variables were compared on 41 plates by Argelander's method, with a sequence of comparison stars. Estimates were made of the difference in grades of each variable from the next brighter and the next fainter star of the sequence. The sum of these differences gives the interval between the comparison stars, and combining all the results gives, in general, several measures of each interval on each plate. Each comparison star in turn may then be regarded as a variable, and its changes in light determined from the next brighter and next fainter star of the sequence. Comparatively few measures were made of the six brightest and the three faintest stars of the sequence. The five intermediate stars were measured on 41, 39, 38, 30 and 30 photographs respectively. On the average, therefore, five stars were measured on 35 plates, which gave a range of 0·12 magnitudes and an average deviation of 0·02 magnitudes. The average deviation 0·02 includes: (1) the errors of observation; (2) errors due to neglecting hundredths of a magnitude; (3) errors due to irregularities in the film which enter with their full value into the result. Since the combined effect of these three sources of error is only $\pm$ 0·02, it is evident that neither of them can be large. The errors due to the film are in fact so small, that there is no evidence that they exist, and more delicate methods of measurements are required to render them perceptible.

THE COMPARATIVE PHYSIOLOGY OF THE SUPRARENAL CAPSULES.[1]

DR. SWALE VINCENT has in previous communications given certain experimental evidence in favour of the view that the paired suprarenal bodies and the inter-renal gland of Elasmobranch fishes correspond respectively to the medulla and the cortex of the suprarenal capsules of the higher Vertebrata. This evidence consisted in the utilisation of the discovery of Oliver and Schäfer that the medulla of mammalian suprarenal contained a substance which, when injected into the circulation, produced an enormous rise of blood-pressure. Dr. Vincent found that the paired bodies of Elasmobranchs contained this active substance, while the inter-renal gland in the same order of fishes and the known suprarenals of Teleosts did not. Thus it appeared that the medullary portion of the suprarenal was absent in Teleosts, the suprarenal bodies in this order of fishes consisting solely of cortex.

Since performing the above experiments his attention has been given to the general physiological effects of extracts obtained from suprarenal capsules. The extracts were made separately from cortex and medulla, and injected subcutaneously into various mammals. It was noted that the injection of medullary material was invariably fatal if a sufficiently large dose were administered, while the cortical extracts produced no appreciable physiological effects. The mode of preparing the extracts was usually by boiling for a short time in water or normal saline, and carefully filtering, as it had been found that boiling, if not too prolonged, did not destroy the active material. The symptoms usually observed were a characteristic progressive paralysis, with occasionally convulsions. Death probably occurred by respiratory paralysis.

Since these effects were only produced by medullary substance, there appeared now to be afforded a still further means of testing the above views concerning the homologies of the two kinds of suprarenal in Elasmobranchs and the corpuscles of Stannius in Teleosts with the two portions of the suprarenal capsules of the higher Vertebrata. Accordingly, in the present communication the hypothesis has been established on a still firmer basis by testing the effects of the two kinds of gland in Elasmobranchs and of the cortical suprarenals of Teleosts, where extracts of them are injected subcutaneously into small mammals. Naturally only very small quantities of material have been available for this purpose, but the effects upon mice have been quite definite. Material from *Gadus morrhua* produced no effects whatever. The paired bodies from *Scyllium canicula* and *Raja clavata* produced characteristic symptoms and a rapidly fatal result. Again, the inter-renal from these genera was found to be inactive. One of the mice certainly which was injected with an inter-renal extract was found dead on the following day, but Dr. Vincent thinks this result can reasonably be attributed to contamination with the paired bodies, and is analogous to the effect one sometimes obtains upon the blood-pressure when inter-renal extract is injected intravenously. The symptoms noted in the mice as the result of injection of the active material were quickened respiration at first, which afterwards became slower and slower, and paralysis commencing in the hind-limbs, and finally affecting the whole body. In one case there were convulsions. In fact, the results were typically those of poisoning by suprarenal medulla.

These experiments afford further positive evidence of the homology of the paired bodies of Elasmobranchs with the medulla of the mammalian suprarenal. The direct evidence in favour of the homology of the inter-renal with the cortex of the suprarenal is mostly morphological and histological, and this the author has detailed elsewhere.

[1] Abstract of a paper entitled "Further Observations upon the Comparative Physiology of the Suprarenal Capsules." By Dr. Swale Vincent. (Read before the Royal Society, November 25, 1897.

MIMICRY IN INSECTS.[1]

SHARING in the perplexity avowedly felt by many of my predecessors in this chair as to the choice of a subject for the annual address—perplexity arising rather from the redundancy than from the scarcity of entomological matter—I have been led to think, considering the wide-reaching importance of the questions involved and the unmistakeable interest shown in the recent discussion at two of our meetings, that some account of the mimetic relations existing among insects might not be out of place. Having for a considerable period devoted some attention to the matter, I propose to pass in review what has been placed on record; and if, in so doing, I traverse ground very familiar to most of us, my excuse must be the fascinating interest which attaches to the whole subject.

EARLY CONTRIBUTIONS TO MIMICRY.

The application by Henry Walter Bates, our lamented President, of the great principle of natural selection in elucidation of the mimicries found among insects is too well known to require any detailed repetition here. It is sufficient to recall that, as the result of many years' experience in tropical South America, Bates established the facts that (1) among the abundant and conspicuous butterflies of the groups Danainæ, Heliconiinæ, Acræinæ, and some Papilioninæ were found very much rarer mimicing forms, chiefly of the group Pierinæ but partly belonging to other groups and some even to the Heterocera, which, departing very widely from the aspect of their respective allies, imitated with more or less exactness the abundant species in question; (2) the numerous and showy Danainæ, &c., although of slow flight, did not appear to be molested by the usual insectivorous foes; and (3) the members of these unassailed tribes possessed malodorous juices not found in the mimicking forms or their allies. From these data he argued that the explanation of these extraordinary resemblances was to be found in the great advantage it would be to species undefended by offensive secretions, and therefore palatable and much hunted down, to find escape in the disguise of species recognised and avoided as unpalatable; and traced the mimicries to the long-continued action of natural selection, perpetually weeding out by insectivorous agencies every occurring variation not in the direction of likeness to the protected forms, but as perpetually preserving, and so aiding the development by heredity of, every variation favourable to the attainment of the protective mimicry.

This sagacious application of the Darwinian theory in solution of one of the most difficult and baffling of the problems presented to zoologists, was of the greatest service and encouragement to all students of evolution. I retain to-day the liveliest recollection of the delight I experienced in the perusal of a copy of Bates's memoir received from himself; for his work was not that of the mere cabinet systematist, but came with all the force of face-to-face commune with the abounding life of the tropics.

Before two years had passed, Bates's explanation of mimicry was confirmed by his former companion in exploration, Alfred Russel Wallace, who, working with equal devotion in the

[1] Abstract of the presidential address delivered before the Entomological Society of London on January 19, by Mr. Roland Trimen, F.R.S.

Malayan Islands, had observed and was able to adduce a strictly analogous series of mimetic resemblances among Oriental butterflies, and gave his unreserved acceptance of the Batesian interpretation. Such support from the co-founder with Darwin of the theory of natural selection, and from a naturalist of the widest experience in both Western and Eastern tropics, was of the greatest weight with evolutionists generally.

My own contribution to the subject was read to the Linnean Society in March 1868. In the previous year I had made an entomological tour in Natal, and had enjoyed some precious opportunities of observing in nature several cases of mimicry between species not inhabiting the Cape Colony. There was no claim to originality in my paper; it simply rounded off the case by adding from Africa, the third great tropical region of the globe, a series of instances and observed facts confirmatory of those brought forward by Bates from the Neotropical, and by Wallace from the Oriental region. Of course I had had nothing like the extended field experiences of those great naturalists, and the African material then available was but scanty; but it so happened that perhaps the most striking and elaborate of all recorded cases of mimicry—that exhibited by the females of the *Merope*-group of *Papilio*—had come under my personal observation in South Africa, and I was thus in a position to describe satisfactorily a wonderful illustration of the Batesian theory.[1]

It will be remembered that Bates, in his memorable paper, also brought to notice the very close resemblances, or apparent mimicries, which unquestionably exist between species belonging to different groups or subfamilies of protected distasteful butterflies themselves; but neither he nor Wallace felt able to give any explanation of these instances, which obviously differed very materially from the cases of mimicry of an unpalatable protected species by a palatable unprotected one. Not until 1879 was there any elucidation of this side of the matter, but in May of that year appeared in *Kosmos*, Fritz Müller's notable paper on "*Ituna* and *Thyridia*," which was translated by Prof. Meldola, and printed in our *Proceedings* for the same year (p. xx.). In this memoir, Müller made the valuable suggestion that the advantage derivable from these resemblances between protected forms was the division between two species of the percentage of victims to the inexperience of young insectivorous enemies which every separate species, however well protected by distastefulness, must pay.

Prof. Meldola not only brought forward and supported, with all his wonted grasp and acumen, F. Müller's daring interpretation of this phenomenon, but in 1882, in a paper discussing the objections brought against Müller's view, made a distinct advance by showing how that view could justly be extended to explain the characteristic and peculiar prevalence of one type of colouring and marking throughout large numbers of species in protected groups—so especially noticeable in the sub-families Danainæ, Heliconiinæ, and Acræinæ.

In 1887 was published Prof. Poulton's most interesting memoir entitled "The Experimental Proof of the Protective Value of Colours and Markings in Insects in reference to their Vertebrate Enemies," which dealt in great detail with the actual results of numerous experiments conducted by himself and other naturalists with the object of ascertaining to what extent highly conspicuous (almost always distasteful) larvæ and perfect insects are rejected or eaten by birds, lizards and frogs. The conclusions given at the close of this paper cover a wide range in connection with the subject of warning coloration, and among them I would call special attention to No. 5, in which the author points out that "In the various species in which a conspicuous appearance is produced by colour and marking, the same colours and patterns appear again and again repeated," and adds that "In this way the vertebrate enemies are only compelled to learn a few types of appearance, and the types themselves are of a kind which such enemies most easily learn." This generalisation certainly had the merit of first detecting a great additional advantage derivable from the common aspect exhibited by a number of protected forms in the extended "Müllerian" associations indicated by Prof. Meldola; and it was applied by Wallace to the case of the Heliconiidæ in the comprehensive survey of warning coloration and mimicry generally given in "Darwinism." We are further indebted to Prof. Poulton for the discussion and summary of all extant data up to 1890 in his "Colours of Animals"— a work which abounds in pregnant suggestion, and indicates with justice and clearness how far the evidence forthcoming was valid, and in what directions evidence still lacking should be sought.

Wallace well observed that "to set forth adequately the varied and surprising facts of mimicry would need a large and copiously illustrated volume; and no more interesting subject could be taken up by a naturalist who has access to our great collections and can devote the necessary time to search out the many examples of mimicry that lie hidden in our museums." A work ostensibly of this character was issued in 1892–93, in two parts, from the pen of the late Dr. Erich Haase, under the title of "Untersuchungen über die Mimicry auf Grundlage eines natürlichen Systems der Papilioniden"; and last year an English translation of the second part was published, and has quite recently been reviewed by Prof. Poulton (NATURE, November 4 and 11, 1897).

RECENT CONTRIBUTIONS TO THE SUBJECT.

Among recent contributions to the subject, we shall, I think, all agree in assigning a high place to the memoirs with which Dr. F. A. Dixey has enriched our *Transactions*. In 1894 he read before the Society his elaborate paper "On the Phylogeny of the Pierinæ, as illustrated by their Wing-markings and Geographical Distribution," and took occasion to discuss the wide divergence from the primitive or typical pattern of the group caused by mimicry in such genera as *Euterpe*, *Pereute*, *Dismorphia*, &c. Adopting the Müllerian interpretation as expanded by Meldola, he proceeded to offer the original suggestion that, in the acquisition of closer resemblance between two or more protected forms, it was not necessary that in every instance the process of adaptation should lie solely in the imitation of one particular form as model, but that there might very well exist *mutual* convergence of the forms concerned, thus accelerating the attainment of the common beneficial resemblance. This "reciprocal mimicry" the author further explained in a paper read in 1896 "On the Relation of Mimetic Patterns to the Original Form" (pp. 72–75), by a consideration of certain mimetic sets of Heliconii, Pierinæ, and Papilioninæ which present features and relations of pattern and colouring explicable apparently in no other way than by the hypothesis in question. This paper also gave a lucid demonstration, traced through corresponding series of existing forms of both mimetic and non-mimetic Pierinæ, of "the successive steps through which a complicated and practically perfect mimetic pattern could be evolved in simple and easy stages from a form presenting merely the ordinary aspect of its own genus," and further adduced reasons for holding that "it is not necessary that the forms between which mimicry originates should possess considerable initial resemblance." In his latest memoir, "Mimetic Attraction," read on May 5 last, Dr. Dixey expanded a suggestion he had previously (1896) made respecting divergent members of an inedible group to point out—still from evidence in the Pierine subfamily to which he has devoted so much fruitful study—"how the process of gradual assimilation starting from one given point may take not one direction only but several divergent paths at the same time," with the result that a more or less intimate mimetic relation was brought about with several protected forms of quite different affinities, though each connected in their colouring and aspect with some group of distasteful associates. He further set forth very fully the distinction which exists between the mimicry of inedible by edible forms, which could only be in one direction and was of advantage to the mimicker alone, and the assimilation among inedible forms themselves, where the mimetic attraction acts reciprocally, to the advantage of all participators.

Another of our Fellows, Colonel C. Swinhoe, distinguished for his wide and intimate knowledge of Oriental Lepidoptera, read before the Linnean Society, in 1895, a most interesting paper "On Mimicry in Butterflies of the genus *Hypolimnas*." In this memoir, as the author points out, a small group of wide-ranging mimetic insects is followed throughout its geographical distribution; and the process of mimetic modification is traced through the female, from the amazing instability of that sex of *H. bolina* (local form) in the Fiji Islands, where the male is stable and of the normal ancestral pattern and colouring, to the opposite extreme in Africa, where (with the exception of *H. misippus*) both sexes of the known allied forms of the genus

[1] At various subsequent dates I was enabled, through the valuable aid of Mr. J. P. Mansel Weale and Colonel J. H. Bowker, to make known to science conclusive evidence of the species-identity of the three mimetic females of *Papilio cenea*, and of the pairing of the widely-differing sexes of that species.

are equally mimetic.[1] The singular contrast between the numerous modifications of the female of the *Bolina* type, and the absolutely constant imitation of *Danais chrysippus* alone by the ♀ *H. misippus* is well brought out, and the different courses thus pursued by the respective females are shown to depend on the range, variation, and abundance of the model that is mimicked. Colonel Swinhoe had previously (1887) published a good account of mimicry in Indian butterflies, and in it made special reference to the remarkable series of close likenesses between species belonging to different subgenera of the great protected genus *Euplœa*.

Mimicry in Various Orders of Insects.

So much prominence has naturally been given to the very conspicuous development of mimicry among the Lepidoptera, that it is not uncommon to hear the matter spoken of as if limited to butterflies and moths, and even entomologists need to be reminded of the prevalence of the phenomenon among other orders of insects. The stinging *Hymenoptera* furnish the most numerous models to members of other orders, being closely mimicked by numerous Diptera, by many heterocerous Lepidoptera, by various Carabid, Heteromerous, and Longicorn Coleoptera, and by some Hemiptera; while certain ants are well imitated by spiders. As regards *Coleoptera*, mimicry is mainly found within the limits of the order itself—*e.g.* Cicindelids by Heteromera and Longicorns, Carabids by Heteromera, Malacoderms by Longicorns, and Rhynchophora by Longicorns; but certain Cicindelid and Rhynchophorous beetles are closely copied by Orthoptera, belonging respectively to the genera *Condylodeira* and *Scepastus*. *Lepidoptera* do not seem to find mimickers beyond their own order, unless the case quoted by Haase from E. Hartert, of the resemblance of a large Cicada to the Indian *Thaumantis aliris* (Morphinæ) be one of actual mimicry. Nor do *Diptera* appear to be models for imitation, except in the case of the hunting spiders, which mimic the Muscidæ they chase; although the neuropterous *Bittacus* certainly bears a strong likeness to Tipula, and may possibly find the advantage of that harmless aspect in approaching its prey. It cannot be denied that some of the inter-ordinal mimicries are even more impressive and striking than those so notable among butterflies, the excellence of the superficial disguise of general outline, proportion of parts, colouring, and markings being so great as to throw into obscurity the really vast structural discrepancies. Such cases as the imitation of the South American wasps of the genera *Polybia* and *Synœca* by moths of the genera *Sphecosoma* and *Myrmecopsis*, of the Bornean sand-wasp *Mygnimia aviculus*, by the beetle *Coloborrhombus fasciatipennis*,[2] or of the Philippine tiger-beetle *Tricondyla*, by the cricket *Condylodeira*, are absolute marvels of deception, all belonging to that special phase of mimicry where the obvious advantage to the unarmed mimic lies in being mistaken for the armed and formidable model.

Returning to the general aspects of the subject, it is of importance to consider more closely how the evidence stands in relation to (*a*) persecution by insectivorous foes, (*b*) possession of malodorous and distasteful juices by certain groups of insects, (*c*) rejection or avoidance by foes of the insects provided with offensive juices, and (*d*) loss occasioned to distasteful species by the attacks of young and inexperienced enemies; for it is admittedly on the co-operation of these factors that the theory of mimicry depends.

(*a*) Persecution by Insectivorous Foes.

As regards the first point, the broad fact of insects generally constituting the food of countless devourers, vertebrate and invertebrate, is beyond dispute; immense and incessant persecution is universally at work. But when we proceed to examine this world-wide persecution more in detail, and to ask in what special directions it works, or what groups or species of enemies are the particular prey of certain groups or species of enemies, we very soon discover how little is exactly known. Birds, for instance, are such notorious and apparently indiscriminate insect-eaters, and some of them are so active and demonstrative in their hunting, that it seems but reasonable to regard them as the chief pursuers on the wing of the abundant and defenceless butterflies. Yet in the discussion which followed the reading of Dr. Dixey's last paper already referred to nothing was more noticeable than the very scanty testimony to such persecution on the part of birds that could be brought forward by the very competent well-travelled entomologists present. In fact, the poverty of observed cases of such attack has induced the opinion among some entomologists that birds very rarely chase butterflies at all, and the published expression of this view by Pryer, Skertchley, Piepers, and other experienced collectors cannot be overlooked. But I am persuaded that in this instance, as in so many others where the life-history of animals is concerned, the dearth of evidence is due to the neglect of well-directed and sustained observation. Little can be gained by merely noting such cases as happen to force themselves on the collector's attention; the collector must resolutely set himself to search out and keep watch upon what really takes place. Considering that there is no record of any naturalist's having seriously taken up the investigation of this matter in the field, I think that very much positive evidence could hardly be expected, and that what has been published goes far in the direction of proving that birds must still be reckoned among the principal enemies of butterflies.

(*b*) Possession of Malodorous and Distasteful Juices by certain Insects.

The presence of malodorous juices in many insects is a matter of common observation, and is a protective property possessed by several entire groups, especially among the Lepidoptera and Coleoptera. There is abundant evidence as to the prevalence of these secretions, and among the Lepidoptera they are particularly developed in the butterflies of the groups Danainæ, Neotropinæ, Acræinæ, and Heliconinæ, and also in some Papilioninæ, as well as in many moths of the groups Agaristidæ, Chalcosiidæ, Arctiidæ, Lithosiidæ, &c. The strength of the disagreeable odour emitted is in some species very great; Seitz, for instance, mentioning that the smell of the South-American *Heliconius besckei* and *Eueides aliphera* extends over a radius of several paces, and Woodmason and De Nicéville testifying to the same effect as regards the Indian *Papilio philoxenus* and allied forms. When molested many of these offensively-smelling species exude drops of a yellow or whitish fluid which leave on anything they touch a stain and odour difficult to remove, as I have experienced in the case of the Mauritian *Euplœa euphone*, the South-African Danainæ and Acræinæ, and various South-African Agaristidæ, Glaucopidæ, and Arctiidæ.

The origin and manner of acquisition of these unsavoury secretions have yet to be discovered; the suggestion (so much insisted on by Haase) that these juices are directly derived from those of similar quality in the food-plants of the larvæ arising from the long-known circumstance that some of the food-plants of species in the protected groups are of an acrid or poisonous character, such as (*e.g.*) Asclepiads in the case of many Danainæ, and Aristolochia in that of the inedible forms of Papilioninæ. No doubt, too, the fact that the unpleasant qualities are very often fully developed in the larvæ of the distasteful species—as I have found with *Danais chrysippus* and various Acræinæ—lends some weight to the suggestion; but at present nothing approaching sufficient data can be brought forward respecting the actual food plants to which the protected groups, in contrast to the unprotected, are thought to be restricted. It cannot be gainsaid, as Prof. Poulton has pointed out (*Proc. Zool. Soc. Lond.*, 1887, pp. 198, &c., and NATURE, November 4, 1897, p. 3), that the food-plants of many of the distasteful European moths do not belong to any poisonous or acrid category; and his own and Mr. Latter's papers on *Dicranura vinula* alone amply demonstrate what powerful acids can be elaborated by a larva which finds its food in such innocuous plants as poplar and willow. The supposed direct derivation of the nauseous juices from the plants consumed is thus plainly a matter that awaits investigation from both biological and chemical standpoints.

(*c*) Avoidance or Rejection of Insects by Insectivorous Animals.

The avoidance or rejection as food by insectivorous animals of the insects possessing malodorous or distasteful juices no longer rests merely on the negative evidence given by Bates, Wallace, Belt, and other competent observers, to the effect that in nature such distasteful forms are habitually neglected and unmolested; there is now much positive experimental evidence

[1] It should be noted that in the African *H. salmacis* and the Malagasy *H. dexithea* the sexes are alike and non-mimetic, and that therefore these species probably most closely approximate to the primitive appearance of the genus.

[2] See Pryer, *Trans. Ent. Soc.*, 1885, p. 369, pl. x., who in the same place also figures another most striking case from Borneo, in which the hymenopterous *Triscolia patricialis* is mimicked by the lepidopterous *Scoliomima insignis*.

as to the manifest avoidance or disgust with which such species are left untouched, or thrown aside after tasting, when offered to domesticated or captive vertebrate animals that devour ordinary insects with avidity. The numerous experiments of this kind recorded by Butler, Jenner Weir, Weismann, Poulton, and Lloyd-Morgan, as regards both larvæ and imagos of European species, are supported by a few made by Belt with Heliconiinæ in Central America, by D'Urban and myself with Danainæ and Acræinæ in South Africa, and by Haase with Danainæ in Singapore.

It is manifest, of course, that even the most distasteful forms cannot enjoy complete immunity from persecution ; in ordinary circumstances they are doubtless mainly kept down by parasitic insects, and during any scarcity of more palatable prey it is certain that they will be devoured *faute de mieux* by vertebrates and invertebrates alike.

(*d*) LOSSES DUE TO INEXPERIENCE OF ENEMIES.

As regards the important point whether the protected forms have to suffer a certain percentage of loss from the attacks of young and inexperienced birds and other animals, it must be admitted that the evidence at present forthcoming is exceedingly scanty ; and I have long felt considerable doubt as to the sufficiency of this factor to account for the mimetic resemblances, often remarkably close, between members of associated protective groups. But on reviewing carefully the recorded observations which appear to bear on the question, I have found reason to think that there is enough support to justify the provisional acceptance of the Müllerian explanation. We have in the first place Fritz Müller's own capture of Heliconii and Acræinæ with a notched piece bitten out of the wings, and Distant's (*l.c.*, p. 65) of a *Danais chrysippus* whose wings had been bitten unsymmetrically, apparently by a bird. Then there is the significant record of Skertchley, who, among twenty-three species of Bornean butterflies taken with both hindwings mutilated in the same manner, notes no less than four Danainæ, viz. *Hestia lynceus*, *H. leuconoe*, *Ideopsis daos*, and *Euplœa midamus.* Moreover, it is very remarkable that several of those entomologists who have specially emphasised the small part played by birds in attacking butterflies mention, among the few cases of such attack as they witnessed, instances of protected forms being assailed, Sir G. Hampson remarking that in South India the Euplœæ and Danaids were caught as often as any others, and M. Piepers that in two of the four cases which he had seen in Sumatra and Java, the species seized were Euplœæ.

The question underlying this is manifestly whether insect-eating animals have an instinctive inherited discernment of what species are unfit for food, or whether, on the contrary, each individual has to acquire this necessary knowledge by personal experience, aided in some vertebrate groups by parental guidance. So numerous and so marvellous are the instinctive or congenital activities of animals—especially in the insect world, where past experience or parental instruction is almost always non-existent—that there has been a very general disposition on the part of naturalists to incline to the former view in a matter so all-important as suitable food. Yet, as far as experiment has hitherto gone in this direction, there seems good ground for holding that—at any rate in such specially insectivorous vertebrate groups as birds, lizards, and frogs—the young possess no such hereditary faculty of discrimination, but have to discover individually what to avoid. This appears not only from Mr. Jenner Weir's and especially Prof. Poulton's careful and often-repeated experiments with lizards and frogs, but also from Prof. Lloyd-Morgan's study of newly-hatched birds of different orders, which indicates clearly with what complete want of discrimination every object of suitable size is at first pecked at and tasted, but how soon experience tells and is acted upon. Prof. Lloyd-Morgan made special trial of these young birds with many distasteful insects and their larvæ, and states in conclusion that he did not find a single instance of instinctive avoidance, but that the result of his observations is that "in the absence of parental guidance, the young birds have to learn for themselves what is good to eat and what is distasteful, and have no instinctive aversions."

In concluding what I feel to be a very incomplete outline of what has been done in this most important branch of zoological research, I cannot refrain from expressing the gratification I find in noting how by far the chief part in the investigations pursued and in the deductions derived from them has from the outset been borne by Fellows of this Society. It is work on which we may with justice be congratulated, and which should encourage perseverance in the same and kindred lines of inquiry.

NEED OF OBSERVATIONS OF LIVING ORGANISMS.

Here, as in many other biological researches, it cannot be too strongly insisted on that no result of lasting value can be hoped for without resort to the living animals among all the natural conditions and surroundings. It was not a stay-at-home theorist, familiar only with the dried specimens of the cabinet, that detected the meaning of mimicry and gave to science a rational explanation of the mystery, but an ardent explorer and naturalist, who devoted many of the best years of his life to field-work in tropical lands. I am the last to undervalue the knowledge of the systematist, which is absolutely indispensable to all intelligible record, and I fully recognise that no naturalist can be properly equipped for his work without a fair amount of systematic training ; but philosophical discovery in any direction such as we are now considering can never be truly advanced without unflagging observation and experiment among organisms living in their natural environment. How but by the closest and most exact attention to the entire life-history of animals in their native haunts can we expect to deal satisfactorily with such questions as this of mimicry, of protective resemblances generally, of seasonal dimorphism, sexual selection, local variation, and the like? Admitting gratefully the good work of this kind which has been carried on in Europe, and especially in our own country, one cannot but regret that from tropical regions, where alone the abundance, complexity, and incessant activity of life afford full prospect of the adequate reward of such research, we have little more than isolated notes and unconnected and incomplete observations, mere indications—precious as they are—of the rich harvest that lies unreaped for lack of resident workers devoted to the task.

It is on this account that I earnestly renew the plea put forward from this chair on May 5 last, for the establishment, in tropical countries, of biological stations for the study of the terrestrial fauna ; where, as in the existing marine biological stations, naturalists could follow, during a succession of seasons, special lines of observation and experiment under favourable conditions of laboratory and other equipment, free from the hindrances and distractions of ordinary collecting travel, and with all the advantages of mutual help and encouragement. The living expenses, for men of the simple tastes of the naturalist, would not be great ; and I feel certain that, with the increasing facilities for swift transport, it would not be long before many students of biology would embrace the opportunity so provided for the effectual prosecution of researches of the utmost value to science.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The usual courses in the Scientific and Medical Departments are being continued this term. Prof. Ray Lankester is lecturing on the "Structure and Classification of Fishes," and Prof. E. B. Poulton on the "Natural History and Classification of Insects." Prof. Tylor purposes to lecture on "Ancient and Barbaric Stages of Culture compared with Advanced Civilisation." The Regius Professor of Medicine (Prof. J. Burdon-Sanderson) proposes to continue his Pathological Lectures of last term by discussing the "Nature and Causes of Tuberculosis."

The examination for the Radcliffe Travelling Fellowship will begin on March 1. Candidates must have passed all the examinations for B.A. and B.M. in the University, and must either have been placed in one of the First Class in one of the Final Honour Schools, or have taken some University prize open to all.

CAMBRIDGE.—Mr. R. H. Biffen, of Caius, has been appointed Demonstrator of Botany; Mr. F. C. Kempson, also of Caius, Demonstrator of Anatomy ; and Mr. H. W. Pearson, of Christ's, Assistant Curator of the Herbarium.

The honorary degree of M.A. has been conferred on Dr. H. A. Giles, Professor of Chinese, and on Dr. W. H. R. Rivers, of St. John's, Lecturer in Experimental Psychology.

Two Shuttleworth Scholarships in Botany and Comparative Anatomy will be awarded at Caius College in March. Candi-

dates must be medical students of not less than eight terms' standing. The value of the scholarships is 55*l*. a year for two or three years. Applications are to be made to the tutors by March 1.

M. GERNEZ, *maître de conferences* at the Paris Normal School, has been nominated director of the chemical research laboratory, in succession to the late M. Joly.

PROF. FRANK CLOWES has been elected Emeritus Professor of Chemistry in the University College, Nottingham, on accepting the position of chief chemist and chemical adviser to the London County Council. He will thus retain his professorial title and status, though no longer performing professorial duties. The following is the resolution of the College Committee :—"Resolved that in recognition of the valuable services rendered to the College by Prof. Clowes, first in organising the Chemical Department, and afterwards for sixteen years discharging the duties of Chemical Professor, and for three years the duties of Principal, an honorary position of Emeritus Professor of this College be conferred upon him."

THE Somerset County Education Committee assists technical education in the county in a number of ways, but no branch of its work is likely to prove of more permanent value than the system of aids to public secondary schools, for the purposes of securing efficient teaching of scientific and technical subjects. These grants usually take the form of capitation grants, with the provision that, if made at all, the minimum amount will be 100*l*. per annum. Schools receiving the grants are open at all times, without previous notice, to inspection by Mr. C. H. Bothamley—the Director of Technical Instruction—or other officer appointed for the purpose by the County Committee. It is satisfactory to find that the increased efficiency of the schools which has resulted from the aid and supervision of the County Committee has led in several instances to a marked increase in the number of pupils attending them. In addition to annual grants the Committee has aided schools by grants for building and equipment. There are, however, still considerable areas of the county in which a supply of efficient secondary education is almost entirely wanting. But the report of the County Committee points out that until local authorities receive the wider powers which it is hoped may be given to it by a Secondary Education Act, it will be almost impossible to provide for boys and girls that adequate supply of secondary education of a modern type, which, it cannot be too often repeated, is the only foundation on which it is possible to rear a system of higher technical education such as will bring the higher sections of the industrial community in this country up to the same level of knowledge of their work as their competitors in foreign countries. It is also now becoming generally recognised that secondary education of the kind referred to is rapidly becoming indispensable to every one who desires to occupy a position of control and responsibility in his particular calling in life, whether he afterwards endeavours to add any higher technical training to his general education or not. The Somerset Committee fully recognise this educational principle, and their report shows that they act upon it so far as teey are able.

SCHOOLS of Science carried on in connection with the Department of Science and Art are schools in which systematic courses of instruction are followed. When these conditions are fulfilled, and a fair proportion of students take advanced courses, a special grant is made to the schools in addition to the ordinary grants. Recently, the Inspectors of the Department were given instructions to report on all cases of Schools of Science where the students leaving at the end of the first year, or at the end of the second year, exceeded twenty-five per cent., the idea being that such schools had no claim to be recognised as true Schools of Science, for a sufficient proportion of the students did not continue the systematic course of work laid down. This action of the Department has met with considerable opposition from teachers and school authorities who wish to obtain the special grant without being qualified for it. Numerous schools which do not fulfil, and never expect to fulfil, one of the essential conditions upon which the institution of a special grant to Schools of Science was originally approved, are yet claiming the special grant for such schools instead of the ordinary grant. The Department has now issued a second memorandum stating that it is not desired to press unduly, by any hard and fast rule of percentage, on those schools which may, if time be allowed them, establish themselves as Schools of Science, when it is clear that there is a *bonâ fide* effort to make them such. More than this cannot very well be conceded, for grants can be earned for instruction in any ordinary science or art school or class, without the creation of a School of Science, in the same form as in a School of Science, *i.e.* on attendance. These grants are large, though not on so high a scale as in a School of Science. The Departmental Circular points out that the only justification of a grant higher than the ordinary one is that the school which receives it should fulfil conditions which are not required from ordinary schools and classes. Whether the conditions required should be in any way modified can only be properly considered when the information called for by the Department has been obtained.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, December 1897.—In accordance with the amended by-laws of the Society (May 29, 1897), by which it was arranged that four New York meetings annually should be held instead of eight, as previously, viz. on the last Saturdays of October, February and April, and an annual meeting in the last week of December, a meeting was held on October 30. The object of the change is to secure greater prominence and interest for each meeting, and to afford the members of the Society a better opportunity for scientific and social intercourse. Each meeting now extends through two sessions, held in the morning and afternoon. Forty-one persons (thirty-seven members) were present, and this after the recent successful meeting at Toronto. Nine papers were read, of which abstracts are given here. Some of the papers are printed in the present number, and others will be published in journals whose titles are given.—Note on hyper-elliptic integrals, by Prof. A. S. Chessin, is one of the papers. If X_r is a polynomial in x of degree r; and $P_m(x)$, $Q_n(x)_1$ . . . polynomials in x of degrees m, n, . . . , we know that the integration of

$$\int f(x, \sqrt{X_r})dx,$$

where

$$f(x, \sqrt{X_r})$$

is a rational function of x and $\sqrt{X_r}$, is reduced to the integration of

$$\int \frac{R(x)dx}{\sqrt{X_r}} \quad (i),$$

where $R(x)$ is a rational function of x. Prof. Chessin gives a practical rule for the integration of (i).—Certain classes of point transformations in the plane, by Dr. E. O. Lovett, was read at the May meeting. It is proposed to apply the transformations to plane curves (spirals) in a subsequent note. The properties discussed and the points of view differ sufficiently (in the author's opinion) from the forms discussed by Laisant (*Nouvelles Annales*, 1868, p. 318) to warrant its publication.—Prof. H. B. Newson in a paper, read at the April meeting, entitled "Continuous groups of circular transformations," has for his object the presentation of the outlines of a fairly complete theory of the continuous groups of linear fractional transformations of one variable. His method differs from the methods of Lie.—Dr. C. A. Scott, in her review of "Julius Plücker's Gesammelte Mathematische Abhandlungen" (edited by A. Schoenflies, 1895), gives a very interesting sketch of this first volume, which contains thirty-nine memoirs by Plücker and Clebsch's "Gedächtnissrede" from the sixteenth volume of the *Göttingen Abhandlungen*. From the "Notes" we learn that Prof. Newcomb, the President of the Society, had chosen the philosophy of hyperspace as the subject of his address at the annual meeting (December 29, 1897).—The valuable list of new publications covers a wide field of mathematical work.

Bulletin de l'Académie des Sciences de St. Pétersbourg, 1896, Tome v. No. 3.—Report of the work of the Russian Archæological Institute at Constantinople, by Th. Ouspensky. The chief work of the Institute is the collection and the study of antiquities; excursions to Trebizonde, Samsun, Sinope and Athens were organised for this purpose. A library and a small museum have been opened.—The declinations of fourteen stars which were observed at Pulkova for the study of the variations of latitude at Kazan, by A. Ivanof.—On vinil-trimethylene and ethylidene-

trimethylene, by G. Gustavson.—Short report of a journey to Novaya Zemlya in 1896, for the observation of the eclipse of the sun, by Prince B. Galitzine. The eclipse observations, as is known, were made under fairly favourable conditions, through a light veil of cirrus clouds. After the eclipse, the expedition made an excursion inland in the high mountain region which covers the island in the north-east of Karmakuly. The excursion lasted only nine days. A glacier, two miles long, was discovered at the head of Karmakulka River; very large *neves* are a characteristic feature of this part of the highlands.

No. 4.—Study of the anatomy of *Acanthobdella peledina*, by A. Kowalevsky (in French), with six engravings.—Report of O. Backlund on his journey to Paris and Odessa, for the unification of the constants accepted in astronomical ephemerides.—On the testing of glycerine and the analysis of wax, by F. Beilstein and R. Rinne (in German).—Note on a dry fog observed in Samara.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, January 19.—Annual Meeting.—Mr. R. Trimen, F.R.S., President, in the chair.—The balance-sheet for the past year, showing a balance in the Society's favour and an improvement in the financial position, was read by Mr. A. H. Jones, one of the auditors. The Secretary then read the Report of the Council, from which it was seen that during 1897 the Society had lost 7 Fellows by death and 5 by resignation, and had elected 24, the total number now on the list being 398. The *Transactions* for the year contained 19 memoirs, illustrated by 11 plates, and extending to 434 pages. As a mark of respect to the late Mr. J. W. Dunning, the Council had decided to present his portrait as a frontispiece to the volume of *Transactions* for 1897. It was announced that the following Fellows had been elected as Officers and Council for 1898:—President: Mr. R. Trimen, F.R.S. Treasurer: Mr. R. McLachlan, F.R.S. Secretaries: Mr. W. F. H. Blandford and Mr. F. Merrifield. Librarian: Mr. G. C. Champion. Other Members of Council: Mr. W. Bateson, F.R.S., Dr. T. A. Chapman, Sir G. F. Hampson, Bart., Mr. M. Jacoby, Mr. A. H. Jones, Dr. P. B. Mason, Mr. O. Salvin, F.R.S., Mr. J. W. Tutt, Mr. G. H. Verrall, and Mr. C. O. Waterhouse. The President nominated as Vice-Presidents Sir George Hampson, Mr. McLachlan, and Mr. Verrall, and his address was then read on his behalf by the Secretary. After briefly reviewing the position of the Society, and referring to the losses sustained by deaths during the past year, especially those of Dr. Fritz Müller, Mr. J. W. Dunning, and Captain E. Y. Watson, the President proceeded to review the subject of mimicry. (An abstract of his address is printed in another part of this issue of NATURE.) On the motion of Lord Walsingham, seconded by Mr. F. D. Godman, a vote of thanks to the President for his able and exhaustive summary of the subject, and for his services during the past year, was carried by acclamation.

Geological Society, January 5.—Dr. Henry Hicks, F.R.S., President, in the chair.—On the structure of the Davos Valley, by A. Vaughan Jennings. Evidence was brought forward to show that the level area, about four miles in length, near Davos, is occupied by superficial deposits, and that the lateral talus-fans there have been cut through at a relatively recent date since their accumulation; that the northern end towards Wolfgang is blocked by moraine-material of great thickness, but for which the Davoser See would drain north to the Landquart, carrying with it the waters of the Fluela and Dischma; that the contour-lines suggest the former existence of a far larger lake stretching south towards Frauenkirch, and that in that part there is proof of the previous existence of a great detrital fan sufficient to account for the existence of the lake in question.—Sections along the Lancashire, Derbyshire, and East Coast Railway between Lincoln and Chesterfield, by C. Fox-Strangways. The portion of the line considered in this paper occupies a distance of about forty miles, and runs nearly at right angles to the strike of all the beds from the Lias to the Coal Measures.

Royal Meteorological Society, January 19.—Mr. E. Mawley, President, in the chair.—The Secretary read the report of the Council for the year 1897, showing that there had been an increase in the number of Fellows and that the finances were satisfactory.—The President, Mr. Edward Mawley, then gave an address on weather influences on farm and garden crops, in which he pointed out the intimate connection between meteorology, agriculture and horticulture. He explained the special characteristics of the climate of the British Isles as regards temperature, rainfall, &c. Of all the influences brought to bear on vegetable life by the atmosphere, he considered temperature to be the most powerful and far reaching, and only second to this came rainfall. The leading effects of snow, wind and sunshine, as well as of prolonged droughts, severe frosts and persistent rains, were also described. He then dealt with the influence of different important weather changes on such farm crops as wheat, roots, grass, &c., as well as on fruit trees, vegetables, and flowering plants in the garden. In his concluding remarks he called attention to the great want of experimental farms in conjunction with meteorological stations being established in this and other countries in Europe. For it was only by the examination of meteorological observations, together with weekly records of the extent and character of the growth made by our leading crops, that the close connection existing between weather changes and their influences on such crops could be clearly traced.—Mr. F. C. Bayard was elected President for the year.

Zoological Society, January 18.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—The Secretary exhibited, on behalf of Prof. Robert Collett, a specimen of a supposed hybrid between the Fieldfare (*Turdus pilaris*) and the Redwing (*T. iliacus*).—Mr. W. E. de Winton exhibited and made remarks on a skin of a zebra from British East Africa, belonging to a form described by Herr P. Matschie as *Equus burchelli böhmi*, obtained by Captain S. L. Hinde at Machakos.—Mr. L. W. Byrne read a paper on the general anatomy of the fishes of the order *Holocephali*. The paper contained a brief account of the anatomy of the soft parts of *Chimæra monstrosa* and *Callorhynchus antarcticus*, and a comparison of them with a typical Elasmobranch such as *Scyllium*.—Dr. W. G. Ridewood read a paper on the development of the hyobranchial skeleton of *Alytes*, in which he showed that of the two axial cartilages present in the larval hyobranchial skeleton of this Batrachian, the anterior one disappears completely, while the posterior, which is remarkable in extending back to the laryngeal sinus, persists as the central part of the body of the hyoid.—Mr. F. O. Pickard-Cambridge read a paper on the Cteniform Spiders of Africa, Arabia, and Syria, which contained a list of the species already described from these countries, with notes on their identities, and descriptions of nine new species.—Mr. L. A. Borradaile gave an account of the Crustaceans of the order Stomatopoda represented in the collections made by Messrs. J. S. Gardiner and Dr. A. Willey in several of the South Pacific Islands. Ten species were enumerated, of which three, viz. *Gonodactylus espinosus*, *Pseudosquilla oxyrhyncha*, and *Squilla multituberculata*, were described as new.

EDINBURGH.

Royal Society, January 17.—Rev. Prof. Flint in the chair.—Dr. Hugh Marshall read a note on the axes of symmetry which are crystallographically possible. In this paper the author gave a proof simpler than that of Gadolin ("Mémoire sur la déduction d'un seul principe de tous les systèmes crystallographiques avec leurs subdivisions"), namely, that if the law of rational indices be assumed, only digonal, trigonal, and hexagonal axes are possible with crystals. The proof rests on the assumptions, that an axis of symmetry is necessarily a possible edge or zone axis, and that there are possible edges perpendicular to any axis of symmetry, *i.e.* that the plane to which it is normal is a possible face. These assumptions are formally proved, and then the proposition that an axis of symmetry of the nth order is crystallographically possible only when $\cos 2\pi/n$ is rational, is proved generally. The value of n is limited by the laws of rational indices to those cases where $\cos 2\pi/n$ is rational. Further, from the nature of an axis of symmetry, n must be a whole number. It is shown by N. Boudaief, in the appendix to Gadolin's paper, that the only values of n which satisfy these two conditions are 2, 3, 4, and 6. Consequently only digonal, trigonal, and hexagonal axes of symmetry are possible with crystals.—Prof. Geikie communicated a paper, by Mr. John S. Flett, on the Old Red Sandstone of the Orkneys.—Dr. R. H. Traquair, F.R.S., had a paper on the fossil fishes of the Orcadian series of the Old Red Sandstone of Scotland. As many as fifty-eight species of fossil fishes had been, up to 1888, named and described from the Orcadian rocks of the Moray Firth area, of Caithness, and

of Orkney; but Dr. Traquair showed that their nomenclature had fallen into a state of chaos, principally by the unnecessary multiplication of species upon deceptive characters, as well as, to some extent, by the confusion of forms which actually were distinct. The previous list was accordingly reduced from fifty-eight to twenty-four, while, during the past ten years, Dr. Traquair has added nine new species, making the entire number up to thirty-three. Of these new species, three are described for the first time in the present paper, namely, *Homocanthus crassus* and *Asterolepis orcadensis*, from Orkney; *Cheiracanthus striatus*, from Caithness. The rest of the paper consisted of an enumeration of the genera and species of Orcadian fossil fishes, their synonymy, and the localities in which they are found in the three areas—Moray Firth, Caithness, and Orkney. No fishes have been found as yet in the Orcadian beds of Shetland. Of the thirty-three species, twenty-seven occur in Caithness, twenty-four in Orkney, and seventeen in the Moray Firth beds, the small number in the last-named area being apparently due to the absence of certain geological horizons, which are represented both in Orkney and in Caithness. The paper was illustrated by limelight pictures of the principal forms of Orcadian fossil fishes, both as they occur in the rock and as restored by the author.

Mathematical Society, January 14.—Mr. J. B. Clark, President, in the chair.—The trisection of a given angle, by Mr. Lawrence Crawford.—The centre of gravity of a circular arc, by Mr. G. E. Crawford.—A demonstration of the apparatus used in practical skiagraphy by the Röntgen rays was given by Dr. Harry Rainy.

PARIS.

Academy of Sciences, January 17.—M. Wolf in the chair.—Notice of the life and works of M. d'Abbadie, by M. Hatt.—On some results relating to the phenomena discovered by M. Zeeman, by M. A. Cornu. Further improvements in the methods of observation give results not altogether agreeing with those of the original experiments. The action of the magnetic field upon the period of vibration of the radiations from a luminous source appears to depend not only upon the chemical nature of the source, but also on the nature of the group of rays in the spectrum to which each radiation belongs, and on its function in this group. If the direction of the field observed is normal to the lines of force, each ray becomes four, and not three as originally announced by Dr. Zeeman.—Remarks by M. Henri Becquerel on the preceding communication.—On the separation and estimation of iodine, bromine, and chlorine, by M. Ad. Carnot. The separation is based upon the removal of iodine by carbon bisulphide after acting upon the mixture with nitrous vitriol; the bromine is then set free by chromic acid at 100°, and removed by the same solvent. Fairly satisfactory analytical results are appended.—On the decimal hour system, the divisions of the day and the circle, and the geographical table, by M. Henride Sarrauton.—Occultation of the Pleiades by the moon, January 3, 1898, observed at the University of Paris, by M. G. Bigourdan.—Occultation of the Pleiades group, observed at Lyons, by M. Ch. André.—On the four large planets, by M. Émile Anceaux. Certain simple numerical relations have been found to exist between the masses and major axes of orbits of Jupiter, Neptune, Saturn, and Uranus.—On the representation of uniform analytical functions, by M. Paul Painlevé.—On the convergence of series representing the integrals of differential equations, by M. Paul Staeckel.—On the irregular integrals of linear differential equations, by M. J. Horn.—On the existence of integrals of a partial system, determined by certain initial conditions, by M. Riquier.—On the systems of triply orthogonal surfaces where the surfaces of a family admit of the same spherical representation of their lines of curvature, by M. Maurice Fouché.—On the basis of projective geometry, by M. H. G. Zeuther.—On the problem of the cooling of a heterogeneous bar, by M. W. Stekloff.—On gas mixtures, by M. A. Leduc. The author proposes to replace Dalton's law, that the pressure of a mixture of gases is equal to the sum of the pressures that each would occupy in the same receptacle, by another, that the volume occupied by a mixture of gases is equal to the sum of the volumes that the component gases would occupy under the conditions of pressure and temperature of the mixture, the two statements being only identical when Boyle's law holds exactly.—Determination of the density of gases on very small volumes, by M. Th. Schlœsing, jun. The method described gives very fair results with quantities of gas as small as 6 c.c., and requires neither the use of a barometer nor a balance. A column of the gas whose density is to be determined is balanced hydrostatically against a column of gas of known density and absorbable by caustic potash, such as carbon dioxide. The manipulation and calculation are extremely simple. Further details and numerical results will be given in a later paper.—On an apparatus called the hermetical pourer, by M. R. Personne de Sennevoy. With the apparatus in question, a diagram of which is given, a portion of a liquid contained in a hermetically closed vessel can be extracted without introducing any other fluid into the vessel.—On the thermodynamic potential, by M. A. Ponsot.—On the spectrum of the kathode rays, by M. Birkeland.—On the spectrum of cadmium in a vacuum tube, by M. Maurice Hamy. The wave-lengths of the ten principal lines were measured with an accuracy of six significant figures.—On the absolute value of the magnetic elements on January 1, 1898, by M. Th. Moureaux. The calculations are made for the elements at Paris, Nice and Perpignan.—Contribution to the study of the electric furnace, by MM. Gin and Leleux.—New method for measuring the intensity of a magnetic field, by M. E. Bouty. A liquid conductor is allowed to flow normally to the lines of force in the field to be measured. The constant electromotive force induced in the liquid vein is measured by means of the capillary electrometer. It was found that tap water served very well for the conducting liquid, and by increasing the velocity of flow the sensitiveness of the method can be increased almost indefinitely. The fields measured were of the order of 0 5 C.G.S. units.—On a thermometric mercury ammeter, by M. Ch. Camichel. A thermometer bulb is placed in a glass tube slightly larger, and the narrow annular space filled with mercury through which the current is passed. The instrument described measures up to 2 amperes with an approximation of 1/200th.—Discharge by the Röntgen rays. Secondary effect, by M. Jean Perrin. The hypothesis provisionally put forward of a superficial phenomena is now shown to be improbable.—On the electrical resistance of crystallised silicon, by M. Fernand Le Roy. The resistance of silicon is about 1300 times that of electric light carbon, and diminishes on heating, a decrease of about 40 per cent. corresponding to a rise of 800° C.—On some new compounds of the cerite metals, by M. Andre Job.—On aldehyde ammonia, by M. de Forcrand. Calorimetric data of the solutions of this substance.—On β-isopropyl-γ-acetylbutyrate of ethyl and on the stereoisomeric acids derived from it by condensation, by MM. Ph. Barbier and V. Grignard.—On the oxidation of ammonia compounds by the ferments of the soil, by M. E. Demoussy. Under the influence of the bacteria of the soil the amines are oxidised to ammonia, and this goes to nitrite and nitrate in the usual manner. The more complex the amine the slower is the course of oxidation. —Bacilli of beriberi, by M. Gustave Nepveu. Three forms of bacilli differing in size ($8\ \mu$, $3\ \mu$ for the two larger) were found, but it is not quite certain that these are distinct forms.—On the structure of the cirrophore in the Polynoïdia, by M. G. Darboux, jun.—On the elongations of the anterior portion of the body of the Prosobranchia and their influence upon the corresponding region of the digestive tube, by M. Alex. Amaudrut.—On a cælomic gregarian presenting a phase of asporulic multiplication in the evolutive cycle, by MM. Maurice Caullery and Félix Mesnil. The new species is a parasite in the general cavity of *Dodecaceria concharum*, and is named *Gonospora longissima*.—Sex and molecular dissymmetry, by M. Félix Le Dantec.—Some remarks by M. Edmond Perrier on the preceding paper.—On the supposed chloragogenesis of the general cavity of the Opheliæ, by MM. J. Kunstler and A. Gruvel.—On the existence of a malacological polybathic fauna at great depths in the Atlantic and Mediterranean, by M. Arnould Locard. Outside the well-defined littoral zones there exists both in the Atlantic and Mediterranean a fauna capable of living and developing at depths of over 2000 metres, to which the name polybathic is given. This fauna contains many Gastropods, and is especially rich in Scaphopods and Lamellibranchs.—On the origin of the double sheath of the root of *Tropæolum*, by M. Camille Brunotte.—On the preparation of gentianose, by MM. Ed. Bourquelot and L. Wardin.—On the germination and hibernal fructification of the truffle, by M. A. de Gramont de Lesparre.—On the mineral layers of oolitic iron of the new basin of Briey, by M. Georges Rolland. Complete geological sections of these important beds of Meurthe-et-Moselle are given.—On the caverns of Sauve (Gard), and the form of the reservoirs of springs and calcareous

soils, by MM. E. A. Martel and A. Viré.—Considerations on the oceanic circulation in the Bay of Biscay, by M. I. Thoulet.—Observation of a double meteor, at Vannes, on January 3, 1898, by M. Georget.—Remarks by M. Callandreau on the preceding note.

In the abstract of the *Comptes rendus* of the meeting of the Paris Academy of October 26, a paper by M. Gaston Séguy on a new method of reducing the time of exposure in radiography was referred to (November 4, 1897, p. 24). Dr. Max Levy writes from Berlin to call attention to the fact that the method described originated with him, and that M. Séguy acknowledged such to be the case in the course of the paper communicated to the Paris Academy.

NEW SOUTH WALES.

Linnean Society, November 24, 1897.—Prof. J. T. Wilson, President, in the chair.—The President formally announced the death of Prof. T. Jeffery Parker, F.R.S., of Dunedin, a corresponding member of the Society, on November 7. It was resolved that an expression of sympathy from the Society should be tendered to Prof. Parker's family.—The President commended to the favourable notice of the members the report of a meeting held at Melbourne, for the purpose of forwarding the movement to establish some permanent memorial of the late Baron von Mueller. It was resolved that it was desirable that steps should be taken to commemorate in some suitable way the late Baron's work, and an influential committee was appointed to carry out the proposal. It is hoped that a sufficient sum of money will be forthcoming to provide for a bust or medallion of the Baron, as well as for the endowment of a medal or prize to be associated with the Baron's name, and to be awarded from time to time in recognition of botanical, pharmaceutical, or horticultural work in the various Australasian Colonies. Subscriptions in aid of this project may be sent to Prof. Baldwin Spencer (The University, Melbourne), one of the hon. secretaries.—Plants of New South Wales, illustrated. Part ix., by R. T. Baker. The species figured and treated of are *Acacia gladiiformis*, A. Cunn., *A. obtusata*, Sieb., *A. rubida*, A. Cunn., and *A. triptera*, Benth., var. nov.—On some New South Wales Fungi, by D. McAlpine. Seven species occurring on the leaves or bark of indigenous trees are recorded. Of these four are described as new, and two are recorded from this Colony for the first time.—Observations on the Eucalypts of New South Wales. Part iii., by Henry Deane and J. H. Maiden. In this third contribution the species dealt with are *Eucalyptus hæmastoma*, *E. Sieberiana*, *E. stricta*, *E. obtusiflora*, and some allied forms.—On some Australian *Eleotrinæ*. Part ii., by J. Douglas Ogilby. Five additional species of Australian eleotrins are described.—On two new Australian fishes, by J. Douglas Ogilby. The two species described are *Harengula stereolepis*, from Torres' Straits, and *Decapterus leptosomus*, a mackerel-scad which annually visits Port Jackson but has hitherto escaped notice.—A contribution to the zoology of New Caledonia, by J. Douglas Ogilby. After alluding to the meagreness of our knowledge of the biology of the island, the author gives a list of the fresh-water fishes referable to six species brought back by Mr. Hedley, with observations thereon.—On Australian *Termitidæ*. Part iii., by W. W. Froggatt.—Eleven species of *Termes*, of which ten are new, and seven species of *Eutermes*, of which five are new, are described. In most cases some account of the nests is also given.—On new Marine Mollusca from the Solomon Islands and Australia, by John Brazier. The Volute described at last meeting from an imperfect specimen is redescribed from a perfect example which subsequently became available. Descriptions also are given of a new cone from Flinders, Victoria, of two from the Solomon Islands, and of a species of *Axinæa* from the Gippsland Lakes Entrance, Victoria.—Observations on Papuan land and fresh-water shells, with descriptions of new species from New Guinea and Western Australia, by C. F. Ancey. From Western Australia the new species *Trachia Froggatti*, *T. orthocheila* and *T. monogramma* are described and figured from material collected by Mr. W. W. Froggatt. New Papuan shells from German New Guinea are *Sulcobasis leptocochlea* and *Chloritis Möllendorffi*, with which is figured *Pupina Beddomei*, described in an earlier volume of the Society's *Proceedings*. Critical observations on sundry Australian and Papuan shells conclude the paper.—Mr. R. T. Baker exhibited specimens of camphor and camphor oil obtained from the leaves of *Cinnamomum Oliveri*, Bail. The yield of camphor is about ½ per cent. It resembles in odour and appearance the ordinary camphor of commerce. Its melting point was between 173·5 and 175, the melting point of ordinary camphor being given as 175° C. Its specific rotation is also almost identical with that of common camphor. The camphor oil was obtained with the camphor, both floating on the surface of the water, and was separated by pressure. The amount of oil was equal to ·364 per cent., but still retained some camphor in solution.—Mr. R. Etheridge, jun., exhibited some drawings of undetermined leaves, presumably of Tertiary age, from Rollo's Shaft, Coolgardie, forwarded by the Government Geologist of West Australia to Mr. H. Deane. Also specimens of leaves, at present undetermined, from a quarry on the Diamantina River, near Birdsville, a little over the Queensland and S. Australian border, in the former Colony, lat. 25° 55′ S., and long. 138° 25′ E. approximately. Mr. R. L. Jack states that Birdsville is "a Lower Cretaceous locality, but it is quite possible that there are desert sandstone tablelands in the neighbourhood, and the plants may come from one of these."—Mr. Edgar R. Waite exhibited (1) examples of *Typhlops aluensis*, Blgr., from Wai Obi, Vuna Pi, Fiji, where they are known to the natives as "Naota." This species was previously known only from the Solomon Islands, and the new record supplies further evidence of the similarity of the faunas of the two Archipelagoes. (2) A New Zealand fish (*Neptotichthys violaceus*, Hutton) recently caught in Port Jackson, and the first recorded occurrence in Australian waters. (3) Two photographs taken at Layson Island (Hawaiian Islands); one exhibits an immense concourse of albatrosses (identified by Mr. A. J. North as *Diomedea immutabilis*, Rothschild) incubating their eggs, and the other the method of collecting and transporting the eggs. This photograph shows, in addition to wheelbarrows and boxes, two railway trains, the wagons of which are literally piled up with eggs. (4) A block of limestone from the Jenolan Caves polished by Rock Wallabies (*Petrogale penicillata*, Gray).—Mr. Fred. Turner sent for exhibition a series of specimens of the grass *Danthonia pilosa*, R.Br., from near Finley, Riverina, with the infloresence affected with a parasitic fungus. Fifteen other species of Australian grasses were known to him as subject to similar attacks. The subject of the effects produced upon stock by feeding on diseased grasses was one well worth investigation.—Mr. Palmer showed a specimen illustrating what he thought might be considered an undoubted case of root-grafting. Also a clump of the galls of *Brachyscelis duplex*, Schrader, from the Blue Mountains; and a quartz crystal or sacred stone presented to his father by an aboriginal of the Port Stephens tribe, fifty years ago.—Mr. North exhibited the sexes of the rare White-vented Wood Swallow, *Artamus albiventris*, which he had shot on Tyreel Station on the Gwydir River; also the nest and eggs of these birds found at the same time in the top of a hollow stump by Mr. E. Stirton, of Moree. Also some siliceous stones, land-shells, berries, pieces of coloured glass, and a galvanised iron screw procured from a play-house of the Spotted Bower-bird (*Chlamydodera maculata*, Gould) on Weebollabolla Station; the parallel walls of the bower were wholly constructed of dried "spear or corkscrew-grass (*Stipa setacea*) set upright in a slight foundation of fine twigs. Likewise, two sets of the eggs of the Pied Honey-eater (*Certhionyx leucomelas*, Cuvier), procured in Western New South Wales near the South Australian border; and the eggs of another Honey-eater, presumably an undescribed species.

AMSTERDAM.

Royal Academy of Sciences, December 24, 1897.—Prof. van de Sande Bakhuyzen in the chair.—Prof. van Wijhe, on an automatic injector for Teichmann's substance, and presented a paper on it for publication in the *Proceedings*.—Prof. van de Sande Bakhuyzen presented, for publication in the *Proceedings*, (*a*) a paper by J. Stein, of Katwijk, on elements of the planet 424 = 1896 DF, and ephemeride for 1898; (*b*) on behalf of C. Easton, a paper on the grouping of the stars in the Milky Way; and (*c*) made some remarks on the distribution of stars in space, which will be inserted in the *Proceedings*.—Prof. Schoute continued a communication, presented on his behalf by Prof. Darboux to the Academy of Sciences of Paris, extending his theory, given there, of the determination of focal curves of plane curves in possession of an axis of symmetry to that of the focal surfaces of surfaces, that admit of a plane of symmetry.—Prof. van der Waals presented, on behalf of Dr. P. Zeeman,

measurements concerning radiation phenomena in the magnetic field. Photographs have been taken of the outer components of the magnetic triplet. Measurements of the distance of the components for lines in the violet and ultra-violet parts of the spectrum are communicated. In the cases of the metals examined—viz. zinc, cadmium, copper, and tin—the magnetic change is of the same order of magnitude in all of them, and independent of the atomic triplet. Some lines are not affected by magnetism.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 27.

ROYAL SOCIETY, at 4.30.—Mathematical Contributions to the Theory of Evolution. On the Law of Ancestral Heredity: Prof. Karl Pearson, F.R.S.—On the Zoological Evidence for the former Connection of Lake Tanganyika with the Sea: J. E. S. Moore.—(1) The Kelvin Quadrant Electrometer as a Wattmeter and Voltmeter; (2) The Magnetic Properties of almost Pure Iron: E. Wilson.
ROYAL INSTITUTION, at 3.—The Halogen Group of Elements: Prof. J. Dewar, F.R.S
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Notes on the Electro-Chemical Treatment of Ores containing the Precious Metals: Major-General Webber, C.B.

FRIDAY, JANUARY 28.

ROYAL INSTITUTION, at 9.—Instinct and Intelligence in Animals: Prof. C. Lloyd-Morgan.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Condensing Apparatus: H. Williams.

MONDAY, JANUARY 31.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Through Somaliland to Lake Rudolf: H. S. H. Cavendish.
INSTITUTE OF ACTUARIES, at 5.30.—Some Remarks on the Valuation of Endowment Assurances in Groups: George J. Lidstone.

TUESDAY, FEBRUARY 1.

ROYAL INSTITUTION, at 3.—The Simplest Living Things: Prof. E. Ray Lankester, F.R.S.
ZOOLOGICAL SOCIETY, at 8.30.—On a Collection of Fishes from the Rio Jurua, Brazil: G. A. Boulenger, F.R.S.—On the Anatomy of an Australian Cuckoo (*Scythrops novæ-hollandiæ*): F. E. Beddard, F.R.S.—On a Collection of Lepidoptera made by Mr. F. V. Kirby, chiefly in Portuguese East Africa: Dr. A. G. Butler.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be further discussed: Reservoirs with High Earthen Dams in Western India: W. L. Strange.
MINERALOGICAL SOCIETY, at 8.—Canfieldite from Bolivia; Specific Identity of so-called "Crystallised Brongniartite" and Canfieldite: G. T. Prior and L. J. Spencer.—On Atacamite from Sierra Gorda, Atacama: G. F. Herbert Smith.
ROYAL VICTORIA HALL, at 8.30.—Insects in a London Back Garden: F. Enoch.

WEDNESDAY, FEBRUARY 2.

SOCIETY OF ARTS, at 8.—The Cinematograph: Jules Fuerst.
GEOLOGICAL SOCIETY, at 8.—Contributions to the Glacial Geology of Spitsbergen: Dr. J. W. Gregory and E. J. Garwood.—On a Quartz-rock in the Carboniferous Limestone of Derbyshire: H. H. Arnold-Bemrose.
ENTOMOLOGICAL SOCIETY, at 8.—On the Larva of Pelophila: Rev. W. F. Johnson and G. H. Carpenter.—New Species of American Rhopalocera: F. D. Godman, F.R.S., and O. Salvin, F.R.S.

THURSDAY FEBRUARY 3.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Comparison of Oxygen with the Extra Lines in the Spectra of the Helium Stars β-Crucis, &c.; also Summary of the Spectra of Southern Stars to the 3½ Magnitude and their Distribution: F. McClean, F.R.S.—The Intimate Structure of Crystals. Part I. Crystals of the Cubic System with Cubic Cleavage—Haloid Salts of the Alkalies: Prof. Sollas, F.R.S.—Researches in Vortex Motion. Part III. On Spiral or Gyrostatic Vortex Aggregates: Prof. W. M. Hicks, F.R.S.—The Pharmacology of Aconitine, &c., considered in relation to their Chemical Constitution: Prof. Cash, F.R.S., and Prof. Dunstan, F.R.S.
ROYAL INSTITUTION, at 3.—The Halogen Group of Elements: Prof. J. Dewar, F.R.S.
LINNEAN SOCIETY, at 8.—On the Muscular Attachment of the Animal to its Shell in some Fossil Cephalopoda (Ammonoidea): G. C. Crick.—The Comparative Anatomy of certain Genera of Cycadaceæ: W. C. Worsdell.
CHEMICAL SOCIETY at 8.—Effect of the Mono-, Di-, and Tri-chloracetyl Groups on the Rotatory Power of Methylic, and Ethylic Glycerates and Tartrates: Percy Frankland, F.R.S., and Dr. Thomas Stewart Patterson.—The Rotation of Ethylic and Methylic Di-monochloracetyltartrates: Percy Frankland, F.R.S., and Dr. Andrew Turnbull.—The Volumetric Estimation of Sodium: H. J. H. Fenton.

FRIDAY, FEBRUARY 4.

ROYAL INSTITUTION, at 9.—Some New Studies in Kathode and Röntgen Radiations: A. A. Campbell Swinton.
GEOLOGISTS' ASSOCIATION, at 7.30.—Annual General Meeting.—Palæolithic Man: E. T. Newton, F.R.S., President.

SATURDAY, FEBRUARY 5.

ROYAL INSTITUTION, at 3.—Cyprus: Prof. P. Geddes.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Nature Study in Elementary Schools: Mrs. Wilson (Macmillan).—Complete Perspective Course: J. H. Spanton (Macmillan)—Practical Electricity and Magnetism: J. Henderson (Longmans).—Ignorance: M. R P. Dorman (K. Paul).—United States Geological Survey: Atlas to accompany Monograph xxviii. on the Marquette Iron-bearing District of Michigan: Van Hise, Bayley, and Smyth (Washington).—Sewer Gas and its Influence upon Health: H. A. Roechling (Biggs).—Traité de Zoologie Concrète: Y. Delage and E. Herouard. Tome v. Les Vermidiens (Paris, Reinwald).—Le Rationnel; G. Milhaud (Paris, Alcan).—Floods of the Mississippi River: P. Morrill (Washington)—Calendario del Santuario di Pompei, 1898 (Valle di Pompei).—Marcello Malpighi e l'Opera Sua (Milano, Dr. F. Villardi).

PAMPHLETS.—Étude sur la Théorie des Comètes Périodiques: M. O. Callandreau.—A Mechanical Cause of Homogeneity of Structure and Symmetry geometrically investigated: W. Barlow (Royal Dublin Society).—A Paper on the Foundations of Projective Geometry: E. T. Dixon (Cambridge, Deighton)—Harmonic Curves of Three Frequencies: Prof. C. S. Slichter (Wisconsin).

SERIALS.—The Garden, Orchard and Woodland, January (Southampton Street).—Engineering Magazine, January (222 Strand).—Journal of the Royal Statistical Society, December (Stanford).—Proceedings of the Physical Society of London, December (Taylor).—Psychological Review, January (Macmillan).—Essex Institute Historical Collections, Vol. xxxiii. (Salem, Mass.).—West Australian Settler's Guide and Farmer's Handbook, Parts 1 to 4 (Perth, W.A., Wigg).—Astrophysical Journal, December (Chicago).—Quarterly Review, January (Murray).—English Illustrated Magazine, February (198 Strand).—The Home University, No. 1 (West).—Zoologist, January (West).—Journal of Anatomy and Physiology, January (Griffin).—Journal of the Chemical Society, January (Gurney).—Bulletin of the United States Geological Survey, Nos. 87, 127, 130, 135 to 148 (Washington).—Proceedings of the Royal Society of Edinburgh, Vol. xxi. No. 6, Pp. 473-549 (Edinburgh).—Journal of the Sanitary Institute, January (Stanford).—Bulletin of the American Mathematical Society, January (New York, Macmillan).—L'Anthropologie, Tome viii. No 6 (Paris, Masson).—Journal of the Franklin Institute, January (Philadelphia).—Neudrucke von Schriften und Karten über Meteorologie und Erd Magnetismus, Nos. 10 and 11 (Berlin, Asher).—Himmel und Erde, January (Berlin, Paetel).—Monthly Weather Review, October (Washington).

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THURSDAY, FEBRUARY 3, 1898.

APPLIED MECHANICS, AND THE WAY TO TEACH IT.

Applied Mechanics: a Treatise for the Use of Students who have time to work Experimental, Numerical, and Graphic Exercises illustrating the Subject. By John Perry, D.Sc., F.R.S. Pp. v + 678. (London: Cassell and Co., Ltd., 1897.)

PROFESSOR PERRY'S position in the Department of Science and Art gives him so wide an influence on the teaching of applied mechanics throughout the country, that a book which expounds and exemplifies the method of teaching he approves will be received with keen interest. But the volume before us has no need of any adventitious claim on the attention of readers. Prof. Perry has the knack of throwing his personality into his books. You may not always agree with him: indeed, nothing would distress him more than to find you doing that; for what is the use of trailing a coat unless a gentleman will be so good as to tread on it? But, at any rate, you will not find him dull. He holds you alike by what he says and how he says it. You recognise in every chapter the fulness of his knowledge, the ripeness of his experience, the freshness of his methods, the individuality of his style. It is a style which some of us are too steeped in convention to enjoy without qualification. I must myself confess to a measure of distaste for the "Clarendons" which flash out every here and there over the printed page, not in headlines, but to emphasise words and phrases in the text. And the numerous "asides" about educational methods and other things are oddly placed in a treatise on applied mechanics. But the most critical reader will find his admiration compelled by the immense amount the book contains of excellent matter not found, or not readily found, elsewhere; and he will admit that the work is pre-eminently alive in every page, and that the author is speaking throughout with a real knowledge of real things.

Prof. Perry describes it as a treatise for the use of students. I should rather say for the use of teachers, and add that every teacher of mechanics should possess himself of a copy. It is certainly not for beginners. A fairly advanced student will find it very helpful, perhaps as a mine in which to dig rather than as a course to be systematically followed. To the teacher of applied mechanics it will prove invaluable, and through him its influence will, I believe, be far-reaching.

It is clear enough that Prof. Perry is addressing the teachers at least as much as the taught. Else what mean the frequent homilies on teaching, such as these?

"We believe that the principles which an engineer really recollects and keeps ready for mental use are very few. . . . We ought to teach him how to learn for himself. Any child can state Newton's second law of motion, and the other half-dozen all-important principles of mechanics, so as to get full marks in an examination paper; the engineer knows that the phenomena he deals with are exceedingly complex, and that only a long experience will enable him to utilise the so easily stated principles" (p. 2).

"The most important lesson for a beginner, however he may have studied mathematics and mechanics, and however able he may be as a mathematician, is this—that he must not go on merely assuming that he knows how to do things; he must know things by **actual trial**. . . . Teachers will notice that things requiring even a little preparation more than other things will gradually become neglected. . . . When we find our system to be going with clockwork regularity, and we feel no worry, we ought to believe that some change is necessary. If we find that the students are not absorbed in their work, we must understand that we teachers are in fault" (p. 3).

"If it is possible we try to learn all our mathematics, mechanics, physics, and chemistry from teachers who are engineers. What acquaintance with these subjects we have ought to be a real knowledge, and not the glib pretence which suffices for examinations. . . . To effect this object we must work many numerical and graphical exercises, and try to conquer our contempt for simple laboratory experiments" (p. 3).

"Our aim is to get students to think, and it is astonishing how difficult it is to effect this object. . . . In the mechanical laboratory I find that even the dullest student begins to think for himself if he is not too much spoon-fed; and if his difficulties are not cleared away by some wretched routine system of laboratory work being adopted by cheap laboratory instructors, the fundamental principles of mechanics will become part of his mental machinery" (p. 56).

In another passage the author insists, with great truth and force, on the desirability of introducing even elementary students to the fundamental notions and symbols of the calculus at the beginning of their study of applied mechanics. And in another he remarks that "Newton's method, the 'Thomson and Tait method,' is very much to be preferred to any other method of starting in the study of mechanics"; and adds, "Every engineer ought to have his T and T′ (the elementary treatise) a well-thumbed book."

Chapter xi. opens with these rather oracular sentences:

"We sometimes assume that our readers know quite well the fundamental principles of mechanics, and then again we assume that they do not. We hope that they agree with us that we are right in proceeding in this way" (p. 242).

One more passage showing the missionary spirit of the author may be quoted:

"A student who works such an exercise as this carefully is getting all sorts of **valuable notions**, not merely of mechanics but of practical mathematics. Unfortunately, twenty academic exercises can be worked out without much thought or trouble to teacher or student, and by the rules of the game this is sufficient for the passing of examinations. For the present, therefore, my advice will be followed by a few earnest students only—the men who want to know, the men who are not merely in search of examination tips, the men who find academic exercises difficult because they think about what they do" (p. 266).

Like all the rest of the book, these *obiter dicta* are full of interest and suggestiveness. With most of what they contend for the present writer heartily agrees. He is disposed, however, to believe that it is not always through excess of thought that men fail even in "academic" examinations.

One great lesson to be learnt from Prof. Perry is the value of the mechanical laboratory as part of the machinery of teaching. Not merely does he preach this in the passages quoted and in others, but the book

is enriched by many examples of the experimental method, and by many illustrations of laboratory apparatus. Readers of Prof. Perry's "Practical Mechanics," of which this book may be regarded as an extension, do not need to be told that in the development of the mechanical laboratory he has done pioneer work of the most important kind. In his preface he refers very properly to the initiative taken by Sir Robert Ball in the teaching of mechanics by quantitative experiments, and he also speaks in altogether too generous terms of work in this direction recently done in the Engineering Laboratory at Cambridge. But it is to Prof. Perry himself that we owe in great measure the idea of a laboratory in which the students themselves carry out such experiments in applied mechanics, and the idea is one for which students, if not teachers, cannot be sufficiently grateful. Nothing contributes so much toward giving men a real and useful grasp of a mechanical principle than they should themselves make quantitative experiments with a piece of apparatus designed to exemplify the principle. But there must of course be some preliminary training in theory, and the work of the laboratory must be in close touch with that of the lecture-room.

In the history of Nicholas Nickleby we are told how Mr. Squeers claimed to "go upon the practical mode of teaching, the regular education system." He taught his boys to spell "winder" and then go and clean it, to spell "bottiney" and then weed the garden. This early and crude example of the laboratory method had two grave defects. The book-work was badly done; and there was no sufficient connection between it and the practical work, for it must be admitted that weeding does not help to spell, nor spelling to clean windows. Add to this that Mr. Squeers quarrelled with his demonstrator, which was impolitic, and that his boys were, in Prof. Perry's words, "too much spoon-fed," and it is not strange that the laboratory method did not commend itself in his hands.

We have changed all that, and as things are now there is perhaps a little danger of the practical work receiving even more than its due share of attention. Valuable as it undoubtedly is, the value of lectures and reading and "paper" work generally is not to be underrated. Prof. Perry does well to insist that the student shall "work many numerical and graphical exercises," as well as "make a great many quantitative laboratory experiments."

By the publication of his "Applied Mechanics" Prof. Perry has made a large addition to the debt which teachers and students of the subject already owe him.

J. A. EWING.

CHARLES CARDALE BABINGTON.

Memorials, Journal, and Botanical Correspondence of Charles Cardale Babington. Pp. xciv + 475. (Cambridge: Macmillan and Bowes, 1897.)

CHAPTERS in the history of the teaching of botany have now been written in the biographies of four Cambridge professors. In 1830 was published Gorham's "Memoirs of John and of Thomas Martyn," a book of small size; and in 1862 Jenyn's "Memoir of the Rev. J. S. Henslow," containing 278 pages. The last of this series, the volume under review, far exceeds the others in size, and contains 570 pages.

The plan of the book divides it sharply into three sections. The first of these sections is occupied by notices from various sources, mostly reprinted from other publications, and diverse in the points from which the views of the different writers are taken. We find Prof. Babington in the light of a college friend from the pen of Prof. J. E. B. Mayor, as a fellow-teacher of science from that of Prof. G. D. Liveing, as a fellow-botanist by Mr. James Britten, as an archæologist, and as a philanthropist. The second section (270 pages) consists of the journal kept by him throughout his long life, and the third section of letters written by him to various botanists. The book closes with a list of his publications, and a very complete index in two parts.

Undoubtedly the greatest interest in the volume lies in the scattered sentences, which refer to the struggle for the recognition of science as an educational subject, in which struggle Babington played no small part. From 1826 until his death in 1895 he resided in Cambridge; and one may remind the reader what an immense change has taken place since the first date, when the Elizabethan statutes were still in force. The early teaching of botany in Cambridge was intermittent. Richard Bradley, professor from 1724 to 1733, seems never to have lectured; John Martyn, his successor, lectured from 1727 to 1734, and Thomas Martyn, who became professor in 1762, lectured for thirty years. In 1825 J. S. Henslow's teaching commenced, and we are told that for seven years his class numbered sixty to eighty. The clearness and charm of Henslow's lectures attracted many of the older members of the University to listen to him, and among these sat for six nearly consecutive years young Babington. After this we learn that the numbers attending the class fell. In 1861 there were no lectures. Babington, meanwhile being elected professor, begins to lecture in 1862, and in 1864 (p. 359) has a class of thirty-five to forty-five students, in 1865 (p. 362) of forty, in 1866 (p. 205) of about forty-five. Such references as these, scattered sometimes in letters, sometimes in his journal, will serve as grist to the mill of a historian wishing to write an account of science in England. The story of Babington's influence for the promotion of natural history, especially in the years before he became professor, is admirably told in Prof. Liveing's memoir on p. lvii.

A regular attendant at the meetings of the British Association, he was one of the founders of the Red Lion Club, a club formed by a little knot of kindred spirits who dined together during the meeting. On p. 85, the founding is thus noticed: "1839. Aug. 29. Yesterday and to-day we formed a private dinner-party at the 'Red Lion' inn (Birmingham), with Dr. Macartney in the chair." Frequent mention of the "Red Lions" occurs in the following pages.

In his letters to J. H. Balfour, A. G. More, and others upon scientific publications, we find him (p. 302) ill-satisfied with the *Phytologist*, and (pp. 288, 291, 306, 312, &c.) very solicitous for the good of Henfrey's *Botanical Gazette* and the *Transactions* of the Edinburgh Botanical Society.

So much for the purely historic side of the book. There occur in the first pages of the journal notes upon insects, and here and there throughout archæological jottings; but the greater part, as one would expect, concerns British plants. The letters are all botanical, and usually express his opinion upon some difficult plant; the journal contains accounts of his "finds" on the excursions which he made in all parts of the British Isles, in the Channel Isles, and in Iceland. Much, indeed, is matter of greater interest to the compiler of a local flora than to the general reader. Yet the history of the changes of opinion upon critical plants, and the notices of the discoveries of forms new to our islands, will appeal to many British field-botanists. To sift the synonymy it is necessary to turn to the first index, where, with the exception of the brambles, the nomenclature of the last edition of Babington's "Manual of British Plants" is followed. One could wish that this sifting of the names had been done in footnotes, in which way it would catch the reader's eye more readily. The index tells us that, on p. 169, *Potamogeton flabellatus* stands for *P. decipiens*, and that *Euphorbia pilosa* appears under five names. Such instances may be here quoted with the remark that reference to this index is very necessary in using the book.

Lastly, in spite of its many pages, the volume is light; the printing is excellent, and the portrait at the commencement a very true likeness. A second portrait, taken at the age of seventeen, occurs at the commencement of the second part, and a pedigree-table occupies a pocket at the end of the book. I. H. B.

DIAMONDS.

Papers and Notes on the Genesis and Matrix of the Diamond. By the late Prof. Henry Carvill Lewis, M.A., F.R.S. Edited from his unpublished MSS. by Prof. T. G. Bonney, D.Sc., LL.D., F.R.S. Pp. 69, with 2 plates and 35 woodcuts. (London: Longmans, Green, and Co., 1897.)

Diamonds. A Lecture delivered at the Royal Institution, Friday, June 11, 1897. By William Crookes, Esq., F.R.S., M.R.I. Pp. 25, with 39 photographs. (*Journal* of the Royal Institution of Great Britain, 1897.)

AMONG the subjects which attracted the attention of the able and versatile geologist of Philadelphia—whose early death was so deeply mourned both in this country and the United States—was that of the mode of occurrence and the origin of the diamond. At the meeting of the British Association at Birmingham in 1886, Prof. Carvill Lewis read a short paper "On a Diamond-bearing Peridotite and on the History of the Diamond"; and in the following year he communicated to the Association meeting at Manchester a much longer and more elaborate paper on the same subject, which was entitled "The Matrix of the Diamond." It was well known to Carvill Lewis's numerous scientific friends in this country that he had collected much valuable evidence concerning the association of diamonds with peridotite and serpentine in all parts of the world, and had arrived at certain very definite views concerning the constant association of the crystalline form of carbon with the ultrabasic rocks.

Geologists are indebted to Prof. Carvill Lewis's widow for the publication of the work, the title of which stands first at the head of this article, in which these two valuable papers have been printed in full, and to Profs. Bonney and Rosenbusch for the painstaking care and sound judgment with which they have been edited. In the opinion of neither the editor himself nor of Prof. Rosenbusch, were the fragmentary notes on the wider and more theoretical questions connected with the origin of the diamond in such a state as would warrant their publication; but Prof. Bonney has been able to add a memoir describing the occurrence of rocks similar to that found in the diamond mines of South Africa—to which Carvill Lewis gave the name of "Kimberlite"—from two localities in the United States. These descriptions are based on information supplied by Mr. J. S. Diller, of the United States Geological Survey, and by the late Prof. G. Huntingdon Williams, of Baltimore, in addition to the notes and specimens collected by the late Prof. Carvill Lewis himself. Geologists now possess, in the work before us, the most complete and satisfactory account of the curious rock in which the diamonds of South Africa are embedded; equal care being devoted to the microscopic structure of the rock, and to the identification of the various minerals present in it.

Turning our attention from the papers of Carvill Lewis to the lecture of Sir William Crookes, it is impossible to avoid being struck with the great advances which have been made, during the last ten years, in our knowledge of the properties and mode of occurrence of that most wonderful and interesting of all minerals—the diamond.

The first part of the lecture of Sir William Crookes is occupied with a popular account of the diamond mines of South Africa and the manner in which they are worked. The author having recently returned from the district, where special facilities had been afforded him for scientific observation, is able to supply a very lively description of the country and its inhabitants, as well as of the operations by which the diamonds are obtained. The reproduction of the photographs with which the lecture was illustrated adds greatly to the value of the pamphlet.

Concerning the properties of the gem, Sir William Crookes is able to supply much valuable information, recently obtained, concerning the intimate relations between diamond and graphite, and the conversion of one material into the other, and also on the action of the Röntgen rays upon the diamond. As a means of distinguishing true diamonds from all kinds of paste imitations, the Röntgen rays appear to be invaluable, for we have here a test which can be applied to cut and mounted materials without any risk of injury to them.

In the decade which has elapsed between the reading of the two scientific communications which we have placed at the head of this notice, the discoveries concerning the mode of occurrence and the artificial formation of the diamond have been of especial importance—and they are admirably summarised by Sir William Crookes in his lecture.

In 1884 Erofeyev and Lachinov showed that an iron meteorite contained diamonds, and this fact was more

recently confirmed by Foote's discovery of diamonds in the Cañon Diablo meteorite, and by that of Weinschenk in the meteorite of Ava. Cliftonite, a form of carbon in cubical crystals, detected by Mr. Fletcher in the meteorite of Youndegin in West Australia, may not improbably be regarded as a pseudomorph in graphite after the diamond.

Finally, Moissan's preparation of diamonds by crystallisation from molten iron has at last solved the long-standing problem of the artificial formation of the mineral.

Sir William Crookes suggests both a deep-seated terrestrial, and a meteoric origin as possible for the diamonds found upon our globe—in both cases the agency of iron as the crystallising medium being invoked. It must not be forgotten, however, that the same mineral species has often originated in many different ways, and it is by no means certain that nature in her laboratories—provided as they are with such abundant resources—has been compelled to resort to precisely the same expedients as we have been led to employ in our experimental researches. J. W. J.

OUR BOOK SHELF.

The Constitution and Functions of Gases. Part iii. By Severinus J. Corrigan. Pp. 179. (St. Paul: Pioneer Press Company, 1897.)

THIS volume is a continuation of the "Constitution and Functions of Gases"—the first two parts of which were reviewed in these columns last year—and deals with the applications of the author's theory to questions of astronomy, treating especially with the genesis and development of the solar system, the age of the sun and the earth and the other planets, and the consideration of the earth from its geological aspect.

It may be remembered that the author in the first part of his treatise expounded a new theory of gases, where, instead of the irregular movements of colliding molecules as developed in the theory of Clausius and Maxwell, the molecule is supposed to remain stationary as a whole, but is made up of a large number of electric or magnetic doublets which revolve in approximately circular orbits with enormous velocities. In this way many of the properties of gases can be readily explained, and the solutions of many interesting problems attempted which, in some cases, agree fairly accurately with experimental results. The theory was ingeniously developed to do away with the necessity of an ether for the transmission of light vibrations through space, by substituting for it a gas of extreme tenuity.

By utilising the general ideas of the nebular hypothesis of Laplace, and by applying the equations obtained in the first treatise, the author proceeds to investigate the genesis and development of the solar system, to determine the ages and temperatures of the planets, as well as a multitude of other important facts, which, if they could only be demonstrated, would place the author on a pedestal by the side of Newton as the greatest astronomer of the age. The fertility of resource of the author in developing his ideas is astonishing, and though at all times the theories are intended to be primarily based on known experimental data, this basis is in many cases so slight and uncertain, and the assumptions so numerous, that the results must be looked upon as mere speculations. The author is equally at home discussing the cause of the Noachian deluge, the nature of vegetation on the planet Mars, and the cause and origin of X-rays.

In the treatment of the earth, the duration of every geological epoch and its cause is determined. The great glacial period is discussed, and, according to the author's views, must be ascribed to the varying intensity of the sun's radiation in past ages.

It is impossible in this short space to enumerate a tithe of the wonderful results that the author obtains; but though there is much that is purely visionary, occasionally some very interesting suggestions are advanced which bear the stamp of probability. The book is written from a scientific rather than a popular point of view, and is chiefly of interest as an example of how an ingenious mind can build up a large and comprehensive theory on very slight foundations. E. R.

A Run round the Empire; being the Log of Two Young People who Circumnavigated the Globe. Written out by their father, Alex. Hill, M.A., M.D., Master of Downing College, and Vice-Chancellor of the University of Cambridge. With 42 illustrations. Pp. viii + 286. (London: Swan Sonnenschein and Co., Ltd., 1897.)

THE Master of Downing jokingly lays claim in his preface to the invention of a new system of education—by taking children for a voyage round the world "before the faculty of observation has been stifled by the study of dead languages, mathematics and other abstract subjects, which have no counterpart in our physical environment." The stifling of the faculty of observation is, one must sorrowfully admit, too often a result of studies conducted in the manner of English schools; but the method of education by travel is surely at least as old as the days of the obsolete Grand Tour; and educational journeys for children form part of the routine of many continental schools.

The short record of a family trip round the world is of a character with which the public is familiar: notes of the trivial incidents of life on board ship, little bits of history, occasional touches of moralising, and vivid impressions of what must have been a very enjoyable as well as a most instructive holiday. The route led by Gibraltar and Naples to Port Said, thence to Colombo, whence a considerable tour in Ceylon was made, on to Australia, Tasmania, New Zealand, Samoa, the Sandwich Islands, and home by the Canadian Pacific Railway and the Atlantic. The young people are indeed to be envied who have so magnificent an opportunity of educating themselves by seeing the world while still unstifled by scholastic cram.

A few slips are not to be wondered at. It is remarked of the Suez Canal that "larger undertakings of the same kind have been carried out since," the diversity in the use of Tacoma and Rainier (not *Ranier* as printed), as names of a mountain, is not correctly described; Morley is transposed to the wrong side of the Rocky Mountains, and Labrador and Newfoundland change places on the Strait of Belleisle. There is, unfortunately, no map; but if read with an atlas, this pleasantly written book should prove a valuable supplement to more formal geographies. H. R. M.

Wild Flowers, and other Poems. By James Rigg. Pp. 294. (Paisley and London: Gardner, 1897.)

IT is not within our province to express an opinion on the metrical merits of this volume. The author is evidently an ardent lover of nature, and of a poetic disposition. We have learnt, by sad experience, not to expect too much scientific accuracy from writers of verse; and the volume before us is not alone in its offences. Still, it does seem strange that the author should not have got some botanist friend to look over his proof-sheets; for by so doing he would have learnt that *Vaccinium europæa* (*sic*) is not the Latin name of the "blaeberry" (*sic*), nor *Stellaria minor* of the chickweed, nor *Pinus borealis* of the Scotch pine. The Latin names are constantly misspelt.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Mathematics used in Connection with Physics.

It may seem ungracious for an author to reply to a review containing so many kind expressions as the one with which Prof. Ayrton has honoured my book on "Electricity and Magnetism" in your issue of November 18; nevertheless, I trust that you will permit me to make a few explanations and even corrections, if the word is permissible.

Since the reviewer states that "it is not quite obvious what is the object of giving" the mathematical introduction, I may state rather more fully than I was able to do in my rather long preface for what class the book was intended. The only class of students with which I come in contact at Clark University is composed of so-called "graduate students," that is men who have taken the bachelor's degree at a college, and are intending to undertake research. It is not generally known that this university was founded for the express purpose of encouraging such men, and consequently, alone among American universities (with the exception of the Catholic University in Washington), has no other students. The same class of students is, however, to be found in large numbers at all the larger universities, so that what I have to say is of general application. These students come to us from all parts of the United States and Canada, and I have had two or three from Europe, so that they have had very various training. They have been at college for four years or more, and have generally taught for awhile themselves. They may have studied the calculus for two years or less, so that although they all know "the meaning of a differential coefficient," and are able to integrate and differentiate with fluency, they are not Cambridge wranglers, and their ideas regarding continuity, convergence of series, definite integrals, and the like, are generally decidedly hazy, while they probably have no acquaintance with the calculus of variations, the theory of functions, and more difficult subjects. It was in order to have some of these matters of most frequent occurrence in a convenient place to refer to that I prefixed the introduction, not with the idea of giving a complete treatment, but to show the student some of the things he should certainly get up, and by means of foot-notes to show him where he could go further. In the numerous kind letters that I have received from teachers of physics in this country, I think all have especially commended the idea of this introduction. At any rate, I had so good an example as Maxwell, who thought it worth while to put a mathematical chapter at the beginning.

With regard to the suggestion that "possibly the students of Clark University, when listening to such lectures as are given in this treatise, have the physical meanings of the various mathematical processes explained to them," which the reviewer intimates would be desirable, I will say that these students have worked generally two years or more in a laboratory, making the usual measurements, and that it is hardly necessary to explain to them what a magnet is, or how a galvanometer is constructed. In order to cover the ground, it was necessary to condense, as the book was already larger than I intended.

Prof. Ayrton asks, "Is it correct to say that 'following the usage of the majority of writers, we shall denote' Laplace's operator (I forbear to write the signs of variation, which the printer has put for round d's) 'by Δ,' seeing that many writers, including Thomson and Tait, use ∇^2 and Maxwell $-\nabla^2$?"

I was rather careful to find this out when writing the passage, and to quote only from the works which I have at hand. I may state that to the two authors named using ∇^2 might have been added the names of Lamb, Minchin, Routh, Basset, and Rayleigh, while the notation Δ is used by Mascart and Joubert, Duhem, Kirchhoff, F. Neumann, C. Neumann, Mathieu, Boltzmann, Helmholtz, Clausius, Drude, Picard, Jordan, Hertz, Klein, and by Poincaré, who calls it *la notation habituelle*. The notation Δ_2 is used by Lamé, Somoff, Boussinesq and Voigt, while Betti writes Δ^2. I did not say "the majority of English writers."

That Gauss's theorem "would be perfectly useless if gravitational, electric, and magnetic forces did not vary as the inverse square," I can hardly agree, seeing that it would be just as true, and would have applications to the flow of heat, hydrokinematics, geometry, and the theory of functions. It is just as well for electricians to remember that the world was not made for them alone.

The reviewer is certainly labouring under a misapprehension when he says "The statement of the general problem of electrostatics, as given at the beginning of § 135, is insufficient since, as pointed out, any number of solutions could be given to it." On the contrary it is explicitly pointed out, at the top of page 265, that there is but one solution, which is completely determined. It is comforting, however, to learn that "the method, however, which is indicated for the solution of the problem is correct, and leads in a neat way to the conception of coefficients of induction"; though the credit can hardly be taken by the present writer, the method being taken from Betti's well-known treatise given among the list of works made use of.

With regard to d'Alembert's principle, I will only say that for the purpose for which it is introduced, namely the deduction of the equations of motion of a system of particles, Hamilton's principle, &c., it seems to me that it makes no difference whether the internal forces appear or not. In any case I have said more about the principle than Kirchhoff, who merely writes down the formula, and Appell, who only says *qui signifie que, pour un déplacement virtuel arbitraire imprimé au point à l'instant, la somme des travaux virtuels de la force d'inertie et des forces reellement appliquées au point est nulle.* Practically the same statement is made by Thomson and Tait, and repeated by Tait in his small book on dynamics.

It seems to me that Green's function is hardly "divorced from its physical application" when it is stated that Green introduced it to solve certain problems in electrostatics. Its physical meaning as the potential of a certain electrification is also given.

The reviewer states that the analogy between electrical and magnetic phenomena is carried too far when the same letter is used for specific inductive capacity on some pages and for magnetic permeability on others. Also that "the beginner might expect to find μ instead of which he finds ϵ; the meaning, however, of this ϵ does not seem to be given." As a matter of fact, it is explicitly stated that μ is used where it refers indifferently to *either* the electric or magnetic quantity, while the meaning of ϵ is given in the next line to the one in which it first occurs, on page 509.

With regard to my "poking fun" at anything or anybody, I beg leave to assure Prof. Ayrton that his statement that "the fun is not intentional on the part of the author" is due to a misapprehension.

Finally, to the suggestion that "a course of 'Lectures on Mathematical Physics' may fitly contain explanations of the physical interpretations of the equations developed without running the risk of appearing to pander to the electrical contractor," it may be replied that much depends upon the point of view. To me the steam-engine or the dynamo are interesting as examples in thermodynamics or induction. I am well aware that this is not the usual view, nor do I suppose it ever will be. I need not conceal the fact that none of my students have ever become engineers. We have an excellent engineering school in our city (which, by the way, is Worcester, and not Webster, as your heading makes it), and we have no reason to try to duplicate the work done there. Some of its graduates have come to us, and have done good work in physics or mathematics. but they have dropped engineering. I say this, not with the slightest wish to disparage engineering or engineers, but to emphasise the fact that there are others to be considered as well.

A. G. Webster.

Clark University, Worcester, Mass., December 15, 1897.

A New Single Picture Pseudoscope.

The principle of the stereoscope is so well known that it is unnecessary to point out that two dissimilar pictures are required of a special character in order to produce the stereoscopic or solid effect. Consequently it may be imagined that to obtain a stereoscopic effect with a single picture is an impossibility.

It is clear that if the possibility exists a *true* stereoscopic combination would not result, but one which would approximate more or less closely to the truth.

Many devices have been brought out in the hope of giving a single picture a solid appearance, such for instance as a large convex lens. All these devices, however, fail to give the desired result. The illusion, so far as it goes, is simply a distortion of the original picture.

The nearest approach to the production of the stereoscopic effect from a single picture is by photographing the illustration with its plane inclined at an angle of the optic axis of the lens, first in one direction, and then again in the opposite direction; in which manner two dissimilar pictures are produced, which can be viewed with an ordinary stereoscope, and the result is by no means unsatisfactory. The process, however, is inconvenient.

For a long time past the writer has been experimenting with stereoscopy, and amongst other objects one has been to secure a stereoscopic effect with a single picture. This he has now succeeded in attaining in a comparatively simple manner.

If a stereoscopic slide is examined it will be found that each picture is compressed, so to speak, on the inner side, which is equivalent to saying that the central line of any one picture is shifted from the centre inwards, thus expanding one half of the picture and compressing the other half.

It therefore appeared to the writer that, if by some means a single picture could be made to give two images, each one compressed in a suitable manner and then viewed with the ordinary stereoscopic lenses, the solid effect should be produced, and such is the case.

The method is as follows:—A large deep cylindrical lens is taken and cut in two along the line where the lens is thinnest. Thus two wedges are produced, each having one side curved and the other side flat. If these two pieces are placed together, with the thick portions towards one another, and held at a short distance over any picture, the eyes will perceive an image of the illustration in each lens, and the pictures will be compressed in the manner already referred to.

All that is now necessary is to view these two images with ordinary stereoscopic lenses. One picture will result, as solid in appearance as if the ordinary stereo-slide had been employed.

The apparatus will be found of considerable use for looking at small photographic portraits, landscapes, &c., as well as engravings. The result is very pretty.

Naturally one class of picture must suffer under the operation; but as these are comparatively rare, there is an extended use for the instrument, which is called the Pseudoscope.

The pictures unsuitable are those which represent an object when placed very near the eyes, since the image produced by solid objects in each eye in such cases differ greatly; but this difference in the image is comparatively small after a distance of, say, 15 to 20 feet. DAVID SALOMONS.

MAGNETIC OBSERVATIONS IN THE HARZ MOUNTAINS.

DR. ESCHENHAGEN has made an interesting series of magnetic observations at forty-two stations in the Harz Mountains.

The uncertainty of a declination observation was about 1′, of the dip with two needles about 1′·2, and the probable error of the horizontal force was about ± 0·00010 C.G.S. units. As it was intended to compare the results with those of a survey of the same district in which the deviations of the plumb-line were determined, the stations were selected with reference to this fact, and also to the geological conformation of the country.

The magnetic disturbances and disturbing forces were determined by a method essentially similar to that employed in the survey of the United Kingdom. The results were not very definite in the northern part of the district examined, but a clearly marked "ridge-line," or locus of attraction on the north-pole of the magnet, was discovered in the south. In one part of this the vertical disturbing force nearly reached 0·00400 C.G.S. units. There are few stations in England and Wales where the disturbance is as large as this, though at Stratford-on-Avon it is exceeded by 25 per cent. At some places purely local attractions of very much larger magnitude were detected. Thus, on the Leistklippe the dip was altered by 11′, and the vertical disturbing force was 0·04224 C.G.S., or one-tenth of the whole vertical force. No such remarkable effects were observed near the principal granitic masses, such as the Brocken.

The fact that the magnetic ridge-line lies to the south of these is explained by the hypothesis that the granitic mass, of which the Brocken is the upper end, extends underground in a direction inclined to the vertical, and running from the surface towards the south. This view is, in the opinion of Dr. Eschenhagen, consistent with the geological facts. As, however, the granite is but slightly magnetic, it is also necessary to suppose that the heavier, more magnetic granite, lies deep, and is only brought near to the surface at a few points such as those at which the greatest local disturbances occur.

The local deviations of the plumb-line were deduced from observations made by the Royal Prussian Geodetic Institute. To the north of the mountains the plumb-line is deflected to the south; from the south an attraction towards the north is detected. The line of no deviation is to the south of the Brocken, and runs nearly parallel to, but about 10–12 km. north of, the magnetic ridge-line.

The remarkable result is therefore attained that (1) geological evidence, (2) the magnetic needle, and (3) the plumb-line all point to the conclusion that the heavier rocks lie some distance to the south of the chief visible masses of granite.

Dr. Eschenhagen is careful to point out that it is unlikely that a similar agreement would be attained in every place where similar experiments might be carried out, as the rocks of greatest density are not necessarily magnetic. None the less, his observations make it probable that the magnet, the pendulum and the plumb-line may add much to our knowledge of the details of the constitution of the crust of the earth; and his survey of the Harz Mountains is one of the most striking attempts which have yet been made to combine the results of magnetic and geodetic surveys. A. W. R.

THE JOURNAL OF ANATOMY AND PHYSIOLOGY.

NEARLY nine years ago, on the occasion of the coming of age of the above-named Journal, we directed attention (NATURE, vol. xxxvii. p. 441) to its association, as a medium of publication, with the then newly established "Anatomical Society of Great Britain and Ireland." Since that time the connection between the two has been maintained, much to the advantage of the Journal, for not only have the "Proceedings" of the Society materially improved and increased in bulk and importance, but many of the leading papers which have appeared in the body of the Journal have reached it through the mediation of the Society, while in the latter's annual reports of its "Committee of Collective Investigation" there have been contributed results of great service alike to the scientific and surgical anatomist. Owing to the death of the founder of the Journal and main supporter during its earlier years, the beloved and universally respected Sir G. Humphry, a reconstitution of the staff of its "conductors" was recently decided upon, and with the issue for October last a new series was accordingly commenced, Profs. Sir W. Turner and J. G. McKendrick, so long associated with its success, announcing that for the future they would be assisted by Profs. D. J. Cunningham, A. Macalister, and G. D. Thane. There has just reached us the second (January) part which has appeared under these new auspices. During the years which have elapsed since our previous notice was written, three of the five present conductors of the Journal have been presidents of the Anatomical Society, while Prof. Macalister, having been on November 26 elected to that office, now combines the two functions. And during the same period the Anatomical Society undertook the preparation, and the conductors of the Journal the publication, of a couple of analytical indexes to its first thirty volumes, entrusting the task to Mr. A. W. Kappel, the efficient librarian of

the Linnean Society of London, who has carried it out with conspicuous success. Society and Journal have thus become more and more closely connected, and to what extent may be gathered from the fact that of the thirty-three papers which make up the body of the first two parts of the new series, fifteen were read at the Society's meetings. Of these, the papers by Prof. D. J. Cunningham and Dr. Elliot Smith on the anatomy of the cerebral cortex and fornix stand pre-eminent, as important communications by leading investigators, who with Symington and others have kept this rapidly developing department of laborious research fully abreast of the continental standard set by von Kölliker, Edinger, Ziehen, and those who have followed in the wake of Golgi and y Cajal. Dr. Elliot Smith's monographs are indispensable to the comparative neurologist, and they amply fulfil the expectation raised by his early investigations in Australia, and justify the graceful comment paid by Sir W. Turner at the summer meeting of the Anatomical Society, held in Dublin in June last, at which one was hurriedly read. Beyond this, the second issue in the new series of the Journal is especially noteworthy for a paper by Prof. Symington upon the thymus gland in Marsupials, about which little indeed is known, and for the first part of one by Dr. D. A. Welsh upon the parathyroid glands, both being exceedingly welcome now that current work upon the ductless- and blood-glands is revolutionising our knowledge and conceptions of these remarkable organs. Noteworthy also is the completion in the same part of a lengthy treatise by Dr. W. McDougall upon a theory of muscular contraction, since by comparison with a remarkable paper by Prof. Rutherford, side by side with which it has for the most part appeared, it opens up fresh themes for controversy upon this interminable topic, which show at least that the last word has not been written concerning it, and that there is sore need of its attack on other than morphological lines. Returning to the first part, we note a paper by Mr. F. J. Cole on the urinogenital system of the male guinea-pig, which for thoroughness of investigation and exhaustive literary research is worthy the standard he adopted in a recent paper on the nervous system of the chimæroids, and the very interesting announcement by Prof. Disse, of Marburg, that the olfactory nerve fibres in the chick arise from cells situated in the epithelium of the olfactory pit, and by Prof. Leboucq, of Ghent, that in the full-grown fœtus of a *Vespertilio* the fourth digit of the manus is tetraphalangeate.

Of the remaining papers one only calls for special comment, viz. that "On the anatomy of *Macropus rufus*," by Prof. Bertram Windle and Mr. F. G. Parsons, since it reveals some strange contradictions both within its own limits and by comparison with the afore-mentioned paper by Symington. It contains a great deal by way of careful and detailed anatomical description which, in correlation with similar papers which its authors have published elsewhere, ought to be of service for reference. Under the heading "Digestive System," however, they have described and figured the liver on one page as destitute of a left central lobe, the lobe present on that side being regarded as a left lateral, while on the very next page the latter is said to be absent. Their first conclusion is based on the relationships of the falciform ligament, unquestionably the only structure of real morphological value for the purpose, and they introduce some pertinent criticism of the methods of other anatomists. All the more remarkable, therefore, their account of certain glands, as said to exist in the "fœtus" (strictly a pouch specimen). On p 132 there is given a processed illustration, little resembling anything in nature, with an accompanying description of glandular structures regarded as "sublingual" and "extra-salivary." That the former are merely the ordinary sub-maxillary glands, there seems no manner of doubt. Concerning the latter, we are assured that "histological examination proved that they were salivary in nature." Great though the backward extension of the salivary glands in some mammals, nothing at all approximate to the remarkable condition here alleged has hitherto been observed, and sufficient is recorded by the authors of the detailed relationships of the so-called "extra salivary" glands to render it tolerably certain that they are but cervical thymus, a conclusion borne out by the authors' confession that they "did not succeed in tracing the termination of their ducts," and by comparison of the descriptions and figures of the neck glands in *M. giganteus* given by Symington, as he justly points out (p. 283). The brief statement which we cite concerning the histology of these glands is wholly insufficient. If they be really salivary, for so extraordinary a condition at least a figure and full details of microscopic sections should have been furnished in absolute proof. While we await with interest further investigation as to the real nature of these, we cannot allow the statements concerning the liver to pass without further comment. Leading anatomical journals other than that now under review might be cited in which inaccuracies unpardonable at times appear. Authors, when inexperienced, will write extraordinary things; experienced authors still more extraordinary. And surely the rendering of Nathusius's well-known name (p. xxix. Suppl.) as "Nathenius," is a matter which the editors, if not the author, should not have allowed to pass. The first two parts of the new issue of the Journal, as a whole admirable and encouraging, give excellent promise for the future, if only the conductors will declare themselves responsible editors and a proper coordination between authors and editors be assured.

GEOLOGY AND SANITARY SCIENCE.[1]

THIS memoir is a new departure on the part of the Geological Survey, being devoted only to applied geology, to questions which have for a long time caused the flow of a steady stream of inquirers to Jermyn Street. It shows how useful is some knowledge of geology to the proper understanding of many matters that are ever cropping up, privately in such things as the choice of a site for a dwelling, and publicly in such as water-supply for a district.

The extent of the district treated is shown by the excellent chromolithographed map, and may be understood from the following list of the border-towns, with London in the centre:—Chesham, Amersham, Beaconsfield, Windsor, Guildford, Dorking, Reigate, Sevenoaks, Gravesend, Billericay, Chipping Ongar, Epping and St. Albans. The colours differ largely from those used on the Survey maps, and the map differs from the lately issued Index Map (on the same scale, four miles to an inch) in showing the various divisions of the Drift; so that there are thirteen colours, besides a blank for Alluvium.

A short description is given of the general structure of the London Basin, with parts of its borders, and then (pp. 7–25) a more detailed account of the beds dealt with, from the Made Ground of London down to the Hastings Beds of the Weald; thus going a little beyond the area of the map, on the south, in which the last are not shown. These are grouped, not in the usual geologic way, but according to character; all gravels and sands being under one heading, all clays under another, with an intervening "mixed sub-soils" for those divisions that decline to be distinctly one thing or another. Under each of the many sub-headings

[1] "Memoirs of the Geological Survey. Soils and Sub-soils from a Sanitary Point of View; with especial reference to London and its Neighbourhood." By H. B. Woodward. Large 8vo. Pp. vi + 58; folding geologic map (13 colours).

the sanitary aspects of the beds are noticed. In the map the index of colours is grouped in three series, clayey, gravelly and sandy, with Alluvium detached at the top, and Chalk at the bottom.

In the rest of the memoir a purely sanitary arrangement is adopted, under four heads, the first being that of the sub-soil with reference to sites for houses (pp. 27–32). The way in which not only the character of the beds, but also their thickness, position, and mutual relations affect the suitability of ground for building-purposes is enforced, and the causes of contamination of porous sub-soils are discussed : even gardens are not neglected.

Secondly, water-supply and drainage are treated (pp. 33–39). After noticing the supply of London, the question of rural water-supply is taken, the causes of contamination of shallow wells and the danger of "dead wells," used as receptacles for sewage, &c., being described. Then we have sanitary considerations in regard to the situation and surroundings of houses (pp. 40–45), under which head subjects other than geologic are referred to, such as surface-drainage, fog, sunshine, rain, wind, floods.

The troublesome question of cemeteries fittingly comes last (pp. 46–48), and the author concludes that "an isolated tract of elevated ground, where sands and sandy loams, or sandy and loamy gravel, of considerable thickness, rest on clay also of considerable thickness, offers the most desirable site," which, however, is qualified by the addition that "probably a sandy and calcareous loam is the best material for a graveyard." However, the difficulty is to get such desirable sites ! The fitting conclusion is a list of the cemeteries in and near London, with the beds on which they are placed, by means of which people who are thoughtful of their latter end can select the geologic formation in which they would like to be buried.

The long index (ten pages), is really more than an index. It is not limited to giving the pages of reference ; but also notes, by figures in another type, the height of the various places above Ordnance datum, and, by means of letters, the beds on which the places are—an ingenious and useful novelty.

Although this is the first Geological Survey memoir devoted to sanitary matters, it should be remembered that stores of information that is useful from a sanitary point of view are to be found in many of those memoirs, especially as regards wells and water-supply.

This work should have a ready sale, as it is written in such a way as to be useful to the ordinary inquirer, and of interest to any intelligent reader ; but the price (2*s*. 6*d*.) is rather high, presumably on account of the map. It is to be hoped that the author may ere long have to prepare a new and enlarged edition, and that the success of the present venture may lead to other work of the same sort being undertaken.

W. WHITAKER.

PROFS. C. RUNGE AND F. PASCHEN'S RESEARCHES ON THE SPECTRA OF OXYGEN, SULPHUR, AND SELENIUM.[1]

IN the above paper Profs. Runge and Paschen have extended their important investigations to the spectra of oxygen, sulphur and selenium, and have discovered in the low temperature spectra of these elements a number of series which are very similar to those previously found for other elements. The principal characteristics of these series are too well known to need any further explanation ; they may be represented by Kayser and Runge's original formula,

$$N = A - \frac{B}{n^2} - \frac{C}{n^4},$$

where N is the wave frequency and n takes up the values 3, 4, 5 . . . for the different lines of the same series. In the present cases n^4 may be with advantage replaced by n^3. We may with equal accuracy take Rydberg's formula,

$$N = A - B(n + \mu)^{-2},$$

where A, B, μ are the three constants. In the spectrum of oxygen which goes by the name of "compound line spectrum," and which Piazzi Smyth has shown to be chiefly made up of close triplets, Runge and Paschen show that these triplets arrange themselves in two series, having approximately the same convergence frequency. The difference in the curve numbers of the components being the same for each triplet, they have all the characteristics of the "Nebenserien" or "associated series," as I propose to call them, because they always occur in groups of two. The formulæ for the strongest lines of the triplets in Rydberg's form is

1st assoc. series : $23207,96 - 110396\,(n - 0{\cdot}02148)^{-2}$
2nd ,, ,, $23200,63 - 109011\,(n - 0{\cdot}24127)^{-2}$

Rydberg has given a law according to which the principal series may be calculated from the associated series, with sufficient approximation to identify the lines belonging to it in the present instance. Only two triplets belonging to it have been found ; the first in the extreme red has a wave-length of 7776 for its strongest lines, and the second, photographed by Runge and Paschen for the first time, has a wave-length 3948. In addition to the triplets, the authors have discovered a number of doublets which can also be grouped into two associated series, having the equations

$$21205,56 - 109366,7\,(n - 0{\cdot}16191)^{-2}$$
$$21211,11 - 110346,7\,(n - 0{\cdot}01093)^{-2}$$

and the principal series belonging to this group is probably represented by two lines at wave-lengths 4368, 5, and 3692, 6, the former being one of the strongest lines of the compound line spectrum.

The result of this investigation of the oxygen spectrum is, that it shows two sets of associated series similar to that found in the case of helium, and that therefore the spectroscopic evidence that helium is a mixture of two gases no longer holds. There is very little doubt that the oxygen spectrum is represented among the Fraunhofer lines ; almost conclusive evidence in favour of this being given by the first triplet of the principal series, which falls at 7776 in a portion of the solar spectrum which is comparatively free from lines. The beautiful photographs of Higg show at this place a triplet the components of which have exactly the right difference in frequency.

Profs. Runge and Paschen also investigated the spectra of sulphur and selenium, and discovered spectra which correspond to the compound line spectrum of oxygen. The spectra consist chiefly of triplets which may be arranged in a group of associated series ; and there are also indications of the existence of two principal series in each case. The authors apparently considered these spectra as due to the elements, but they have only been able to obtain them in the presence of oxygen. Further investigation is therefore required to show that they are not really oxide spectra. Should this prove to be the case it would be a matter of some importance and great interest, for it would show that we must consider the compound line spectrum of oxygen as due to a compound molecule, an "oxide of oxygen" similar in constitution to the oxides of sulphur and selenium which give the analogous spectra.

In conclusion, I may add a few remarks as to the relative merits of Rydberg's and Kayser and Runge's equations. The greater simplicity in form of

$$N = A - \frac{B}{n^2} - \frac{C}{n^4}$$

adopted by Kayser and Runge, and the ease with which the constants may be calculated would, independently of

[1] *Wiedemann's Annalen*, vol. lxi. p. 641.

other considerations, lead us to give the preference to this form. The advantage is not, however, great, and disappears when we have to distinguish cases where we must substitute n^3 for n^4. The reason why I prefer Rydberg's form at present lies in the fact that it adapts itself better to bring out the regularities as well as the irregularities of distribution of the lines independently of any special form of equation. To show this we may write Rydberg's equation in the form

$$\frac{n+\mu}{\sqrt{B}}=\frac{1}{\sqrt{A-N}}.$$

The convergence frequency, A, may be determined by some graphical process if a sufficient number of lines have been observed, and the law of formation of a spectroscopic series may therefore be expressed as follows:

The inverse square roots of the difference between the convergence frequency and the frequency of successive lines are very approximately in arithmetical progression. If we wish to determine how far any series conforms to this law, we may in the first place calculate the right-hand side of the above expression with some approximate value of A. Systematic deviations from arithmetical progression may then be corrected by a small change, δA producing a difference $\frac{\delta A}{\sqrt{(A-N)^3}}$ in the numbers. But it will nearly always be found that there are some outstanding deviations which cannot be corrected for in this way. The value of B is found at once from the arithmetical progression successive numbers differing by $\frac{1}{\sqrt{B}}$. I have found this method of testing the series and calculating the constants very useful, and hope on some other occasion to return to it.

ARTHUR SCHUSTER.

UNDULATIONS IN LAKES AND INLAND SEAS DUE TO WIND AND ATMOSPHERIC PRESSURE.

IT is generally known that considerable variation takes place in the level of the surface of the water in lakes and inland seas owing to the effect of the wind in gales and during stormy weather. The minor undulations which occur at more regular intervals have not attracted the same observation, and the cause of these is still a matter of some uncertainty. In the large lakes in America, fishermen and boatmen have learnt to regard these undulations as storm warnings; and on the coasts of Europe, the rollers which break on the shore in calm weather are looked upon as indicative of a coming storm. Thus, in the Bay of Biscay frequently during the autumn and winter in calm weather a heavy sea gets up and rolls in on to the coast four-and-twenty hours before the gale which causes it arrives, and of which it is the prelude. In this case the wave action, generated on the other side of the Atlantic by the wind, travels at much greater rate than that of wind, and thus gives timely warning of the coming storm. So also on the opposite side of the Atlantic, on the coast between North Carolina and Cape Hatteras, the currents, which are there largely governed by the wind, begin to run strongly several hours in advance of the wind which causes them. In summer a change of the current from north-east to south-west is always taken as a true indication of an approaching north-east wind.

The effect of gales on tideless seas and lakes is so marked as to cause frequently considerable inconvenience and anxiety to mariners. Thus, in the Caspian Sea a gale will raise the water on one side 6 feet and depress it on the other as much, making a total difference of level of 12 feet.[1] In the Baltic easterly gales will alter the level upwards of 8 feet. In Lake Erie[1] depressions and elevations of from 2 to 4 feet are common, while occasionally heavy gales have produced a difference of level of upwards of 15 feet. Almost invariably about the time of the spring equinox strong gales occur from the east, raising the water from 4 to 6 feet at the west end of the lake, and depressing it to a similar extent at the east end, making a total difference of from 8 to 12 feet. About the time of the autumn equinox gales from the west lower the water 7 to 8 feet at the west side, and raise it 5 to 8 feet at the east end, making a difference from the normal level of from 12 to 16 feet. An illustration is given by Mr. Blunt, the engineer, who reported on the subject for the United States Commission as to the way in which the navigation of the lakes and of the rivers connected with them is affected by storms acting on the surface of the water. A steamer which had to make a trip down the river found the water at the pier from which she started, five miles from the mouth, had receded to 7½ feet below the normal level. In the river, flats were showing where a few days before they had found 8 feet of water. In the middle of the bay a large dredger was aground where there ought to have been 17 feet of water.

In addition to these larger oscillations, there are also minor undulations which occur at varying intervals, the largest period for a complete oscillation not exceeding half an hour, and the alteration in the level of the water not more than from three to four inches. The phenomena had been noted by Duillier on the Swiss Lakes in the middle of the last century, the name locally given to them being *Seiches*. In 1804 Vaucher also investigated the matter and published an account of his researches, his experience being that they were common to all the lakes; that they recurred at all seasons of the year, but most frequently in spring and autumn, the greatest oscillation, however, occurring in the summer; and that the intervals between the oscillations did not exceed twenty to twenty-five minutes, and more frequently less.

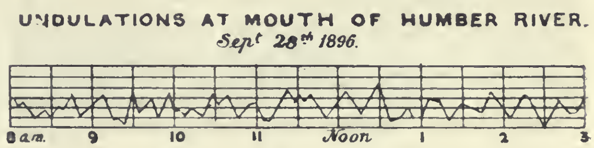


FIG. 1.

A few years since the writer had occasion to investigate the oscillations which took place in one of the Norfolk Broads, and which were taken as showing that the water was tidal. It was found that variations of from half an inch to two and three inches in the level of the water took place periodically, and at times when the atmosphere was calm. Observations spread over a considerable time proved that these undulations were not coincident with the rise and fall of the tides, and that they had no direct connection with the ebb and flow in the river with which this Broad was connected.

The character of the undulations on Lake Superior has been investigated by Mr. Napier Denison, and the results communicated to the Canadian Institute in February 1897, in a paper entitled "The great lakes as a sensitive barometer." For the purpose of tracing these curves Mr. Denison had two self-recording gauges constructed, one being fixed at the mouth of the river Humber, and the other at the Burlington Canal. The results of one day's reading at the mouth of the Humber are shown in Fig. 1, which is sufficient generally to illustrate the result of the readings obtained, and as showing the rapid undulations upon the lakes during light winds and fine weather preceding a severe storm. (The divisions in the above

[1] "Tidal Rivers," chap. v. (Longmans, Green, and Co.).

[1] Report of Deep Waterways Commission, U.S.A. (Washington, 1897).

diagram represent inches.) The undulations generally vary from three to four inches at intervals of from fourteen to eighteen minutes. The centre of the storm which caused these oscillations was over the State of Florida, 1300 miles distant. This storm centre travelled slowly but directly to the lake region, where it caused a severe gale. These lake undulations are found to be of a more sensitive character than the indications of approaching storms given by the barometer. Mr. Denison is of opinion that these oscillations are due to the action of atmospheric waves or billows in passing over the surface of the lakes, which tend to form minute undulations upon the surface corresponding in length to these billows, and becoming magnified when they reach narrower and shallower portions, until finally they assume the proportions recorded upon the instrument.

Attention has also recently been directed to the minor undulations which occur in tidal waters by Mr. W. Bell Dawson, the Government surveyor engaged in the tidal survey of the Gulf of St. Lawrence, in a paper presented to the Royal Society of Canada in May 1895, entitled "Notes on secondary undulations." These undulatory disturbances in the regular rise and fall of the tides in the Gulf of St. Lawrence are plainly marked on the records of the self-registering tide gauges, their magnitude being in proportion to the amplitude of the tides. Similar undulations have also been observed in the Mediterranean at Malta. The illustration (Fig. 2, taken from Mr. Dawson's paper) shows the character of these undulations at high and low water in part of the Bay of Fundy, on tides having an amplitude of from 17 to 19 feet.

W. H. WHEELER.

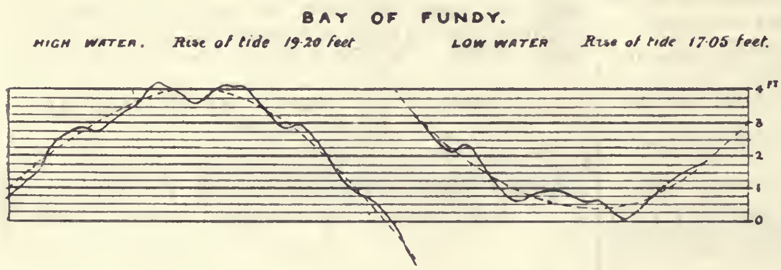


FIG. 2.

NOTES.

THE meeting of the Royal Society on Thursday, February 24, will be devoted to a discussion of the "scientific advantages of an Antarctic Expedition." The debate will be opened by Dr. John Murray, F.R.S., of the *Challenger*.

PROF. L. CREMONA, professor of higher mathematics in the University of Rome, has been elected a Correspondant of the Paris Academy of Sciences, in succession to the late Prof. Sylvester.

H.R.H. THE PRINCE OF WALES has been graciously pleased to accept the post of Patron of the fourth International Congress of Zoology, to be held at Cambridge next August.

A MEETING will be held in Manchester on February 16 to take into consideration such steps as may seem desirable to assist the Executive Committee in making the Zoological Congress this year thoroughly successful. The Literary and Philosophical Society have put their rooms at the disposal of the meeting, and Mr. J. Cosmo Melvill will take the chair at 5 o'clock on that day. This appears to us to be an excellent movement, and one worthy of imitation in other large centres. Zoologists who propose to be present should communicate with Prof. Hickson, F.R.S., at the Owens College, Manchester.

MR. THOMAS H. BLAKESLEY has resigned his seat at the Council Board of the Physical Society. He is, therefore, no longer hon. secretary of that Society.

IT has been decided to publish, under the auspices of the Physical Society and the Institution of Electrical Engineers, a series of abstracts of English, American, and foreign papers on physics and electrical engineering.

THE Harvard University, Cambridge, Mass., has invited Dr. Hans Reusch, Director of the Norwegian Geological Survey, to give two series of lectures—one on "Vulcanism," the other on "the Geology of Scandinavia." Dr. Reusch will return to Christiania in June.

AT the annual meeting of the Royal Microscopical Society on Wednesday, January 19, the President, after reviewing the progress in microscopical science during the past year, gave for his address an account of the manner in which achromatic doublets and triplets were practically calculated. The President explained by drawings on the blackboard the general scope of the paper, which, owing to its mathematical treatment, could not be read verbatim.

THE death is announced of Dr. Samuel Newth, author of "A First Book of Natural Philosophy," which has had a very large sale, and "The Elements of Mathematics, including Hydrostatics." In 1855 Dr. Newth became professor of mathematics and ecclesiastical history in the New College, St. John's Wood, and succeeded Dr. Halley as principal of the College in 1872, retiring from this post in 1889.

WE learn from *Science* that, at the meeting of the Corporation of Yale University on January 13, Prof. O. C. Marsh, professor of palæontology, formally presented to the University the valuable scientific collections belonging to him, now deposited in the Peabody Museum. These collections, six in number, are in many respects the most extensive and valuable of any in America, and have been brought together by Prof. Marsh, at great labour and expense, during the last thirty years. They include collections of vertebrate fossils, fossil footprints, invertebrate fossils, recent osteology, American archæology and ethnology, and minerals. The palæontological collections are well known, and were mainly secured by Prof. Marsh during his explorations in the Rocky Mountains. They include most of the type specimens he has described in his various publications. The collection of osteology and that of American archæology are also extensive and of great interest. The present value of all these collections makes this the most important gift to natural science that Yale has yet received. The President and Fellows of Yale accepted Prof. Marsh's gift by a unanimous vote, and expressed their high appreciation of his generosity to the University.

AMONG the papers to be read at forthcoming meetings of the Society of Arts are the following:—Ordinary meetings (Wednesday evenings, at eight o'clock): February 23, children's sight, by Mr. R. Brudenell Carter; March 2, kites, their theory and practice, by Captain B. F. S. Baden-Powell; March 9, Linde's method of producing extreme cold and liquefying air, by Prof. J. A. Ewing, F.R.S.; March 16, the recent history of paper-making, by Mr. Clayton Beadle; March 23, the preparation of meat extracts, by Mr. C. R. Valentine; March 30, telegraphy across space, by Prof. Silvanus P. Thomp-

son, F.R.S. Indian Section (Thursday afternoons, at 4.30 o'clock): February 17, the plague in Bombay, by Dr. Herbert Mills Birdwood; March 31, the earthquake in Assam, by Mr. Henry Luttman-Johnson. Foreign and Colonial Section (Tuesday afternoons at 4.30 o'clock): February 15, the goldfields of Klondike and British Columbia, by Mr. W. Hamilton Merritt. April 5, the sugar industry in the West Indies, by Mr. T. R. Tufnell. Cantor Lectures (Monday evenings, at eight o'clock): Prof. W. Noel Hartley, F.R.S., the thermo-chemistry of the Bessemer process (three lectures); Dr. D. Morris, C.M.G., india-rubber (two lectures); Prof. Carus Wilson, electric traction (four lectures).

A FEW particulars with reference to the late Dr. George Henry Horn, President of the American Entomological Society, are given in the *Entomologist's Monthly Magazine*. Dr. Horn was born April 7, 1840, in Philadelphia, and died November 24, 1897. He graduated in medicine in 1861, and from 1862 to 1866 was surgeon in the U.S. army. Subsequently he established himself as a physician in Philadelphia, and had an extensive practice. Before he graduated he published papers on recent and fossil corals, but eventually turned his attention entirely to North American *Coleoptera*, as a pupil of, and fellow-worker with, Leconte, until the death of the latter in 1883, and afterwards on his own account. It has been said that if the death of Leconte was a severe blow to North American coleopterology, that of Horn is probably greater. His first entomological paper was published in 1860, and was followed by others (jointly or separately) to the number of about 150, appearing almost entirely in America, but he worked out the *Eucnemidæ* for the "Biologia Centrali-Americana." As already announced, his collections, and a sum of money, have been left to the American Entomological Society, of which he had been long President.

PROF. DAVID P. TODD, Director of Amherst College Observatory, Amherst, Massachusetts, U.S.A., has nearly completed a bibliography of eclipse research to join on with Ranyard's classic work published many years ago in the *Memoirs* of the Royal Astronomical Society. He would be glad to receive copies of papers and titles of works and articles published since 1875.

THE Lincolnshire Science Society, the establishment of which was referred to in NATURE of December 30, 1897, should apparently have been christened the Lincoln Science Society; for a prospectus just received shows that a Lincolnshire Naturalists' Union has been in existence several years. There is hardly room for two county Societies having the same aims and objects, and the establishment of the new Society cannot but have a prejudicial effect upon the older Union, which ought to represent the combined forces of the different local societies in Lincolnshire. For the spirit of competition to enter into the matter at all is a mistake, and if the two organisations do not arrive at a concordat, the work of one will prejudice rather than assist the work of the other. It appears that the Lincolnshire Naturalists' Union initiated a scheme for the formation of a County Museum before the new Society took up the matter.

IN the last number of the U.S. *Monthly Weather Review* (October 1897), the editor draws attention to a proposal for establishing a meteorological station on Satulah Mountain, North Carolina, at an altitude of about 5000 feet. The summit of the peak is fairly level, and, with the exception of about a quarter of a mile, is accessible by vehicles. Prof. Abbe points out that a continuous record at the summit would undoubtedly contribute to the elucidation of some interesting meteorological problems, but that in view of the many unsuccessful attempts to maintain self-recording instruments in isolated places, watchful observers would be necessary. Systematic observations are being made at great elevations by means of balloons and kites, and these efforts may be usefully supplemented by renewed attention to the establishment of mountain stations.

AT the meeting of the French Meteorological Society on January 4, M. Moureaux made an important communication on the results of a mission entrusted to him by the Imperial Geographical Society of St. Petersburg with reference to the magnetic exploration of the Government of Koursk. The whole area of this province is intensely disturbed, and the differences between theory and observation are so great that it is not possible to draw isomagnetic lines. At two points situated about 450 yards apart the declinations are $-11°$ and $+45°$. In one district the declination at two stations about a mile and a quarter apart varied from $-34°$ to $+96°$. The dip ranged from 48° to 79°, and the horizontal component reached 0·59, whereas the maximum normal value of this element in the equatorial regions is below 0·40. From these observations it results that the magnetic force in that locality is as great as it would be in the immediate vicinity of the magnetic poles. So far as is known at present, there is nothing near the surface of the ground to cause these anomalies.

THE tracing of the pretty curves formed by compounding pendulum vibrations of different periods is a fascinating pastime of which we were beginning to believe the resources were pretty well exhausted. Prof. Charles Schlichter, of Winconsin, has, however, discovered "fresh woods and pastures new" by extending the method to space of three dimensions, and representing, by the aid of the stereoscope, the resultant of harmonic motions of three frequencies in three different directions mutually at right angles. To do this, Prof. Schlichter attaches a miniature electric lamp to the bob of a Blackburn pendulum vibrating in a horizontal plane, and photographs the tiny speck of light by means of a stereoscopic camera attached to a pendulum which swings in a vertical plane about a horizontal axis through the optical centres of the lenses. This last pendulum gives the third vibration-component. When the diagrams are viewed through the stereoscope, the curves spring out into relief like bent wires; their forms for many of the higher ratios, such as 5 : 6 : 9 or 5 : 8 : 9 being very striking.

EXPERIMENTS on the action of Röntgen rays on vegetable life have hitherto mostly led to negative results; but Signor G. Tolomei, writing in the *Atti dei Lincei*, is led to the conclusion that their action is identical with that of light. On exposing to the action of Röntgen rays branches of *Elodea canadensis* immersed in water charged with carbonic anhydride, evolution of bubbles took place as in the presence of sunshine or electric or magnesium light. The same similarity was observed in the effects on the lower vegetable forms, both Röntgen rays and light causing retardation in the absorption of oxygen by *Mycoderma aceti*, and in the evolution of carbonic anhydride by Saccharomyces. Again, in their action on *Bacillus anthracis* the Röntgen rays behave in the same way as sunshine, but in a minor degree; when a gelatine film was exposed for twenty-four hours to the radiations from a Crookes' tube, with the interposition of a zinc screen having an X-shaped aperture, the letter appeared transparent on an opaque background. That the action was due to destruction of the germs, and not to the generation of any toxic quality in the agar, was proved thus: when a sterilised film was partially exposed to the rays, and subsequently brought into contact with a stratum of dried spores, the spores began to germinate all over the film; but when the stratum of spores was exposed to the rays, the screen with the letter X being interposed, and the film subsequently brought into contact with them, only those spores which had been protected

from the Röntgen rays developed, and the letter X was distinctly seen. Signor Tolomei attributes the previous failure to obtain such effects to the short duration of the exposures.

A lengthy report of the Committee, appointed by the Academy of Science and Literature at Montpellier, to inquire into the alleged vision through opaque objects, appears in *La Semaine Médicale* (January 19). The Committee prepared three letters, the contents of which could not be known to them, by writing words and numbers on sixty-four cards, placing them two and two into envelopes, and selecting three of the thirty-two envelopes haphazard; these three were carefully sealed. One envelope was sewn into the coat, another placed in the pocket of a member; the third, along with half an exposed photographic plate, was wrapped in many thicknesses of paper and placed in a box, which was also sealed. At Narbonne the box containing the envelope and plate was placed on Dr. Ferroul's table, since that was the usual position of the documents which had already been read by Mlle. X. The Committee then walked to Mlle. X.'s abode, about 300 metres from Dr. Ferroul's house. Mlle. X. did not succeed in reading the contents of the envelopes carried by the members of the Committee, and at first no success attended attempts to describe the contents of the sealed box. About an hour and a half after the commencement of the séance, during which time Mlle. X.'s sister passed to and fro, and Mlle. X. herself left the room on more than one occasion, the contents of the box were more or less correctly described. On re-examining the box the Committee came to the conclusion that it had been opened, and on developing the contained piece of photographic plate along with the other part, the former piece was fogged, although the latter developed perfectly.

The British Medical Journal of January 22 contains a reprint of the special inquiry on the relative efficiency of certain kinds of water filters which has been carried out for the *Journal*. Many of the conclusions arrived at are by no means encouraging; for example, an examination of the portable filters supplied for Army Field Service revealed the fact that not one of these afforded any protection against water-borne disease; that, on the contrary, "they would tend to increase rather than diminish the risk incurred by those making use of them, since when such filters had once been charged with contaminated water they would continue for some time afterwards to discharge the disease germs into the 'filtered' water." This is a very serious matter, and which, considering the numbers of cases of dysentery which have already occurred in the present Indian frontier war, might well demand the immediate attention of the Army Medical Department. The filter of the future remains as yet, it would seem, "a castle in the air"; where efficiency is procured, the rate of filtration is often such as to preclude it from practical use. It appears, however, likely that diatomaceous earths or natural stone will be generally preferred to denser media such as porcelain, these three being, amongst the materials at present in use for filters, the only ones which apparently supply an efficient filtering medium. The same number of the *Journal* contains a communication by E. H. Hankin on "a simple method of checking cholera in Indian villages," which consists in treating the wells in an infected district with potassium permanganate, a sufficient quantity being added in each case to give a pink colour lasting for several hours to the water. This plan appears to have produced favourable results in combating cholera outbreaks, and in some places even the natives have been induced to disinfect their wells by its means.

The immense lava-sheets that cover an area of some two hundred thousand square miles in the Deccan of India have been looked upon as the grandest example of vulcanism in the world; but an even more extensive outpouring of similar material must formerly have been evident in the northern hemisphere, if we accept the conclusions reached by Messrs. Newton and Teall from a study of the geological collections made in Franz Josef Land by the Jackson-Harmsworth Expedition (*Quart. Journ. Geol. Soc.*, December 1897). That archipelago is formed of the fragments of an ancient basalt-plateau which must have stretched far beyond its present limits. Similar igneous rocks are found in Spitsbergen, Jan Mayen, Iceland, Greenland, the Faeroës, the Hebrides and North Ireland; and the authors are inclined to regard all these areas as the isolated fragments of a formerly continuous land-area, the greater part of which has sunk to form the northern portion of the North Atlantic Ocean. The period of this outpouring of lava was probably the end of Cretaceous and beginning of Tertiary times. This period seems to have been distinguished by similar occurrences in other parts of the world, for the great lava-flows of the Deccan and of Abyssinia are of the same age.

Prof. A. Riccò contributes to the latest *Bollettino* of the Italian Seismological Society an account of the Geodynamic Observatory of Catania, founded in 1891, and now one of the best equipped in Italy. It is situated beneath the astrophysical observatory, in the cellar of the former Benedictine convent. The principal instrument is one of Cancani's great seismometrographs, consisting of a pendulum 25·3 metres long and a mass of 300 kg., whose movements are magnified twelve and a half times, and recorded by two pens on a strip of paper moving at the rate of 60 cm. an hour. In addition to this valuable apparatus are two other seismometrographs (Brassart's and Cecchi's), a Guzzanti microseismoscope, one of Agamennone's photographically recording tromometers, a Cancani photochronograph, which, at the moment of a shock, photographs the face of a clock, four seismographic pendulums of different lengths and masses, ten seismoscopes of various patterns for calling attention to the occurrence of a shock, and a puteometer which records the movements of the water-surface in a well 32½ metres deep.

We have received from the Meteorological Reporter for Western India a copy of his "Brief Sketch of the Meteorology of the Bombay Presidency for the Year 1896-97." The weather during the year presented several features of unusual character; for instance, unseasonable distribution of rainfall, for, although the annual amount was above the average in most districts, the deficiency was very great in September and October, and it was owing to this that the crops withered and caused widespread famine. Another feature was the prevalence of abnormally high temperatures; in April and October the means were respectively 6° and 7° above the average. These conditions appeared to have considerable effect upon the plague; from August to November the mortality increased with an abnormal rise of temperature, and *vice versâ*, whereas the high temperature of April appears to have had the effect of decreasing the mortality in that month. This report contains some interesting details of floods in the river Tápti since 1727; the highest flood on record—viz. 100¼ feet—occurred in July 1883, while that of July 1896—viz. 98 feet—occupies the third place on record.

The part for January 1898 of "The Garden," edited by Mr. W. Robinson, presents a very attractive contents to the gardener and horticulturist. There are longer or shorter notes on almost every department of gardening; and no less than four coloured plates, besides numerous woodcuts, are included in the price of one shilling.

In the *Journal* of the Royal Society of Bengal for 1897 (part ii. No. 2) is a brief article by Mr. F. Finn, of the Indian Museum, on the Theory of Warning Colours and of Mimicry. It records

a series of experiments on a tree-shrew, *Tupaia ferruginea*, and on a bull-frog, *Rana tigrina*, but the results do not appear to be very conclusive.

DR. L. MESCHINELLI, of Vicenza, has issued a prospectus of a proposed Iconograph of all Fossil Fungi at present known. It will be published, probably in the earlier half of the present year, in the form of a quarto volume, with an atlas of more than thirty plates. The price to subscribers will be 30 francs, delivered free.

IN a paper in *Natural Science* for August 1897, Mr. G. W. Bulman adopts very much the view of Prof. Plateau, that bees are not primarily attracted to flowers by their conspicuous colour, especially that they have no special partiality for blue. He also contests the statement that either honey-bees or wild bees are constant in their visits to the same species. Somewhat similar results appear to have been arrived at by Mr. Albert Gale from observations in Australia, of the record of which we find a commencement in the *Agricultural Gazette of New South Wales* for November 1897.

IN our recent review of the "Vita Medica" of the late Sir B. W. Richardson, the author's part in emphasising the distinction between "enteric and typhoid (*sic*) fevers" was alluded to (p. 265). Our readers perceived at once, no doubt, that the name "typhoid" had crept into the text in place of typhus.

UNDER the title of *The Home University*, the publication of a magazine and note-book for private students of various branches of knowledge has just been commenced. The idea of the editors of the new periodical is to give the home-student assistance on difficult points, and furnish him with aids to memory. "We shall assume," it is added, "that, in addition to a knowledge of their own language, our readers possess the rudiments of French, Latin, German, and Greek, and that respecting Geography, History, Poetry, and the Natural Sciences they have made some kind of a beginning." The editors purpose not so much to try to increase knowledge as to convey it, and we wish them success in their undertaking, notwithstanding the fact that science takes a minor place in the first number of their educational medium. The periodical is published by the Educational Museum, Haslemere, and by Messrs. West, Newman, and Co.

THE additions to the Zoological Society's Gardens during the past week include a Red Fox (*Canis fulvus*) from North America, presented by Mr. F. C. Ingram; four Virginian Opossums (*Didelphys virginiana*) from North America, presented by Mr. J. D. Sprunt; two Secretary Vultures (*Serpentarius reptilivorus*) from South Africa, presented by Mr. J. E. Matcham; a Laughing Kingfisher (*Dacelo gigantea*), a Lace Monitor (*Varanus varius*), a Blue-tongued Lizard (*Tiliqua scincoides*), two Stump-tailed Lizards (*Trachydosurus rugosus*) from Australia, presented by Mr. J. D. Waley; a Leopard (*Felis pardus*) from Ceylon, a Derbian Wallaby (*Macropus derbianus*) from Australia, deposited; two Uvæan Parrakeets (*Nymphicus uvæensis*) from the island of Uvea, Loyalty Group; two Black-headed Caiques (*Caica melanocephala*) from Demerara, an Ashy-black Ape (*Macacus ocreatus*) from the East Indies, three Curlews (*Numenius arquata*), three Oyster-catchers (*Hæmatopus ostralegus*) from Holland, purchased.

OUR ASTRONOMICAL COLUMN.

THE SOLAR ECLIPSE.—Mr. F. W. Dyson, the Chief Assistant at the Greenwich Observatory, has sent the following letter to the press:—"Prof. Turner telegraphs from Bombay that the observations of the solar eclipse were very successful. The photographs taken by the Astronomer Royal, Prof. Turner, Captain Hills, Mr. Newall, and Dr. Copeland, have all been developed, and the results are excellent. Captain Hills has succeeded in photographing the spectrum of the reversing layer, and Prof. Turner has obtained marked results as to the amount of polarisation of the corona."

LARGE AND SMALL PROPER MOTIONS.—In the *Astronomische Nachrichten* (No. 3466) Prof. Kapteyn announces the discovery of a star with an exceedingly large proper motion; this is the star in the Cordoba Zone Catalogue 5·243h., of about the 8th magnitude, but probably slightly variable, and having an orange-yellow colour. Its position from the "Cape" observations of 1897·8 for epoch 1875 is α = 5h. 6m. 56·0s., and $\delta = -44° 60'·530$, which position is in the constellation of Pictor. The result of the investigations of Mr. Innes, of the Cape Observatory, and Prof. Kapteyn, gives the proper motion in a great circle as 8″·7, or in R.A., + 0·621s., and Decl. − 5″·70, which will be seen is even greater than that of the "runaway" star 1830 Groombridge, the proper motion of which, it will be remembered, is 7″·05 in a great circle, or in R.A. + 0·346s., and Decl. − 5″·78. We shall await with interest the determination of the parallax of this remarkable star, in order to discriminate whether its large proper motion is real or chiefly due to its close proximity to our system.

In contrast with the above, Mr. J. G. Porter has re-computed the proper motion of the star Bradley 2444^a = 3250, availing himself of a much longer series of observations than those from which Dr. Auwers deduced the values +0·0040s. and +0″·128; and while Mr. Porter's result of + 0·0024s. and − 0″·030 (as given in the *Astronomical Journal*, No. 422) confirms the small motion in right ascension, it negatives entirely the motion in declination; he therefore suggests that Dr. Auwers' result seems to have been due to a wrong reduction of the declinations of D'Agelet and Lalande.

THE COMET OF 1892 II.—It is not often that an opportunity occurs of basing the determination of a comet orbit on observations extending over so long a period as that available in the present instance. The series commenced in 1892, March 19, and ended 1893, January 12, during which period the comet passed over about 107° of true anomaly. The definitive orbit in this case proves to be hyperbolic, and the final result is entitled to considerable weight. The only unsatisfactory feature about it is the amount of the residuals in some of the normal places. Dr. L. Steiner, of O'Gyalla, who has made the calculations, bases them on Dr. Schorr's elements, from which he derives by comparison with his computed ephemeris, twelve normal places, necessarily varying considerably in point of accuracy. The solution of the equations of condition founded on these normal places gives for the excentricity the value 1·004404. The residuals to which we have referred as not being quite satisfactory do not occur at the end of the series, when the comet would necessarily be faintest and the observations scarcest, but in the middle of the series, practically from June to October. This is to some extent perhaps to be explained by the fact, that the comet was about that time very faint in telescopes of moderate size, and these observations, made with difficulty, may have had an injurious effect on those derived from the use of larger instruments. This explanation is not entirely satisfactory, for in one instance the normal place rests entirely on the measures made at one Observatory, that of Bordeaux. Dr. Steiner tries by alterations of the assigned "weights" to reduce these residuals, but the result is not quite satisfactory. Under the best circumstances, and when the excentricity is brought down to 1·000345, the sum of the squares of the residuals in the hyperbola is 103″·2, while on the assumption of parabolic motion the same sum is 279″·5. The orbit is almost perpendicular to the plane of the ecliptic.

WINNECKE'S COMET = *a* 1898.—From further observations made by Prof. Perrine at the Lick Observatory a new ephemeris of this comet has been determined; this, together with the elements, are given in the *Astronomical Journal* (No. 424) as follows:—

Elements.

T = 1898 March 20·392 G.M.T.

$$\left.\begin{aligned} \omega &= 173^\circ\ 21'\ 10''\cdot0 \\ \Omega &= 100\ \ 51\ \ 45\cdot5 \\ i &= 16\ \ 59\ \ 34\cdot0 \end{aligned}\right\} 1898\cdot0$$

$$\log e = 9\cdot854161$$
$$\log a = 0\cdot510521$$

Ephemeris for Greenwich Midnight.

1898.	App. α h. m. s.	App. δ ° ′ ″	log Δ
Feb. 1·5	17 25 1·63	−10 53 56·4	
3·5	34 33·95	11 17 21·0	0·1527
5·5	44 14·66	11 39 50·2	
7·5	17 54 3·34	−12 1 18·5	0·1457

The nearest bright star to the comet during this period is *o* Serpentis, which rises about four hours in advance of the sun.

Rowland's Tables.—In the December number of the *Astrophysical Journal*, tables of *corrections* and *additions* to Prof. H. A. Rowland's table of solar spectrum wave-lengths are given. The errors in wave-length have been carefully determined for the whole table, but the identification of solar lines with the lines of the elements in the spectrum of the electric arc has been revised only from wave-length 3722 to 4175. Therefore the corrections and additions to the identifications have been given only for the most important lines between these limits. A few small solar lines have been added to the table.

The changes in wave-length are few, most of them being additions to the identifications.

Nebulæ near Castor.—Prof. Barnard records in the *Astronomical Journal* (No. 422) a list of new nebulæ which he found with the 12-inch equatorial when he first went to Mount Hamilton, and which have remained unpublished until now. There are five within less than a degree of Castor, whose positions here given are reduced to 1860·0—the epoch of Dreyer's New General Catalogue.

No.	α h. m. s.	δ ° ′	Description.
1	7 24 23	+31 44·4	Close p. 10 mag. star.
2	7 24 43	+31 35·5	Small, faint.
3	7 25 12	+31 40·5	Small, 3 S ∗s in curve 2′ p. ±
4	7 25 27	+31 40·5	Very, very faint.
5	7 25 59	+31 31·0	Small, faint.

Prof. Barnard remarks that he has discovered several nests of these nebulæ, but in most other cases the individual nebulæ are very much smaller.

Dr. Karl Necker.—The name of yet another astronomer has to be added to the death roll of last year. Dr. Karl Necker, who occupied the position of assistant in various observatories, was unfortunately killed in a railway accident at Cairo, to which town he had removed for the benefit of his health. Born in 1867, and with his University career only completed in 1893, he entered first the Strassburg Observatory as a temporary assistant, but after a few months removed to Vienna, and in the Küffner Observatory devoted himself to making a series of observations on the prime vertical. When Dr. Halm left Strassburg to occupy his present position at Edinburgh, Dr. Necker returned to fill the vacancy thus created, and was engaged in the fundamental meridian work. But his health compelled him to take long rests, and finally he was recommended to reside in Cairo, where he hoped to secure a position in the Khedival Observatory. This hope was defeated by his tragic death, while making a short excursion to the Sinai Peninsula.

INSTINCT AND INTELLIGENCE IN ANIMALS.[1]

Biology is a science not only of the dead but of the living. The behaviour of animals, not less than their form and structure, demands our careful study. Both are dependent on that heredity which is a distinguishing characteristic of the organic world. And in each case heredity has a double part to play. It provides much that is relatively fixed and stereotyped; but it provides also a certain amount of plasticity or ability to conform to the modifying conditions of the environment. Instinctive behaviour belongs to the former category; intelligent behaviour to the latter. When a caterpillar spins its silken cocoon, unaided, untaught, and without the guidance of previous experience; or when a newly-mated bird builds her nest and undertakes the patient labours of incubation before experience can have begotten anticipations of the coming brood; we say that the behaviour is instinctive. But when an animal learns the lessons of life, and modifies its procedure in accordance with the results of its individual experience, we no longer use the term instinctive, but intelligent. Instinct, therefore, comprises those phases of active life which exhibit such hereditary definiteness as fits the several members of a species to meet certain oft-recurring or vitally-important needs. To intelligence belong those more varied modes of procedure which an animal adopts in adaptation to the peculiar circumstances of its individual existence. Instinctive acts take their place in the class of what are now generally known as congenital characters; intelligent acts in the class of acquired characters.

But the study of instinct and intelligence in animals opens up problems in a different field of scientific investigation. They fall within the sphere not only of biological but also of psychological inquiry. And in any adequate treatment of their nature and origin we must endeavour to combine the results reached by different methods of research in one harmonious doctrine. This involves difficulties both practical and theoretical. For those invertebrates, such as the insects, which to the naturalist present such admirable examples of instinctive behaviour, are animals concerning whose mental processes the cautious psychologist is least disposed to express a definite opinion. While the higher mammalia, with whose psychology we can deal with greater confidence, exhibit less typical instincts, are more subject to the disturbing influence of imitation, and, from the greater complexity of their behaviour, present increased difficulties to the investigator who desires carefully to distinguish what is congenital from what is acquired.

Nor do the difficulties end here. For the term "instinct" is commonly, and not without reason, employed by psychologists with a somewhat different significance, and in a wider sense than is necessary or even desirable in biology. The naturalist is concerned only with those types of behaviour which lie open to his study by the methods of direct observation. He distinguishes the racial adaptation which is due to congenital definiteness, from that individual accommodation to circumstances, which is an acquired character. But for the psychologist instinct and intelligence comprise also the antecedent conditions in and through which these two types of animal activity arise. The one type includes the conscious impulse which in part determines an instinctive response; the other includes the choice and control which characterise an intelligent act. When a spider spins its silken web, or a stickleback builds the nest in which his mate may lay her eggs, the naturalist describes the process and seeks its origin in the history of the race; but the psychologist inquires also by what impulse the individual is prompted to the performance. And when racial and instinctive behaviour is modified in accordance with the demands of special circumstances, the naturalist observes the change and discusses whether such modifications are hereditary; but the psychologist inquires also the conditions under which experience guides the modification along specially adaptive lines. Each has his part to play in the complete interpretation of the facts. And each should consent to such definitions as may lead to an interpretation which is harmonious in its results.

In view, therefore, of the special difficulties attendant on a combined biological and psychological treatment of the problems of animal behaviour, I have devoted my attention especially to some members of the group of birds in the early days of their life. And I shall therefore draw my examples of instinct and intelligence almost entirely from this class of animals. The organisation and the sensory endowments of birds are not so divergent from those of man, with whose psychology alone we are adequately conversant, as to render cautious conclusions as to their mental states altogether untrustworthy; when hatched in an incubator they are removed from that parental influence which makes the study of the behaviour of mammals more difficult; while the highly developed condition in which many of them first see the light of day affords opportunity for observing congenital modes of procedure under more favourable circumstances than are presented by any other vertebrate animals. Even with these specially selected subjects for investigation, however, it is only by a sympathetic study and a careful analysis of their behaviour that what is congenital can be distinguished from what is acquired. For from the early hours of their free and active life, the influence of the lessons taught by experience makes itself felt. Their actions are the joint product of instinct and intelligence, the congenital modes of behaviour being liable to continual modification in adaptation to special circumstances.

[1] A Friday evening discourse delivered at the Royal Institution, on January 28, by Prof. C. Lloyd Morgan.

Instinct appears to furnish a ground-plan of procedure which is shaped by intelligence to the needs of individual life. And it is often hard to distinguish the original instinctive plan from the subsequent intelligent modification.

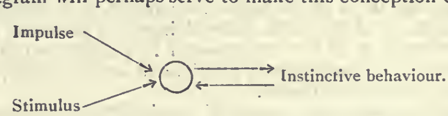
It is not my purpose to describe here in detail, as I have done elsewhere, the results of these observations. It will suffice to indicate some of the more salient facts. In the matter of feeding, the callow young of such birds as the jackdaw, jay, or thrush, instinctively open wide their beaks for the food to be thrust into their mouths. Before the eyes have opened the external stimulus to the act of gaping would seem to be either a sound or the shaking of the nest when the parent bird perches upon it. Under experimental conditions, in the absence of parents, almost any sound, such as a low whistle, lip-sound, or click of the tongue, will set the hungry nestlings agape, as will also any shaking or tapping of the box which forms their artificial nest. And no matter what is placed in the mouth the reflex acts of swallowing are initiated. But even in these remarkably organic responses the influence of experience soon makes itself felt. For if the material given is wrong in kind or distasteful, the effect is that the bird ceases to gape as before to the stimulus. Nor does it continue to open the beak when appropriate food has been given to the point of satisfaction. These facts show that the instinctive act is prompted by an impulse of internal origin, hunger, supplemented by a stimulus of external origin, at first auditory but later on, when the eyes are opened, visual. They show also that when the internal promptings of hunger cease, owing to satisfaction, the sensory stimulus by itself is no longer operative. And they show, too, that the diverse acts of gaping and swallowing become so far connected, that the experience of distasteful morsels tends, for a while at least, to prevent further gaping to the usual stimulus.

With those birds which are active and alert soon after hatching, the instinctive acts concerned in feeding are of a different character. At first, indeed, the chick does not peck at grains which are placed before it; and this is probably due to the fact that the promptings of hunger do not yet make themselves felt, there being still a considerable supply of unabsorbed yolk. Soon, however, the little bird pecks with much, but not quite perfect, accuracy at small near objects. But here again experience rapidly plays its part. For if distasteful objects, such as bits of orange-peel, are the first materials given, pecking at them soon ceases; and if this be repeated, the little bird cannot again be induced to peck, and may even die of starvation. This makes it very difficult to rear by hand some birds, such as plovers, whose natural food, in due variety, is not readily obtainable. It must be remembered, too, that under natural conditions the parent bird calls the young and indicates with her beak the appropriate food; and this appears to afford an additional stimulus to the act of pecking. Pheasants and partridges seem to be more dependent on this parental guidance than domestic chicks, and they are more easily reared when they have somewhat older birds as models whose pecking they may imitate. Passing allusion may here be made to a type of instinctive response in some respects intermediate between the upward gaping of the jay and the downward pecking of the chick. It is seen in the young moorhen, which pecks upwards at food held above it and cannot at first be induced to take any notice of food on the ground. Under natural conditions it is fed by the parent, which holds the food above the little bird as it floats on the water.

We have then, in these simple instinctive acts, examples of behaviour which is congenitally definite in type for each particular species; of actions which are the joint product of an internal factor, hunger, and an external factor, sensory impressions; of complex modes of procedure which subserve certain vital needs of the organism. It should be mentioned, however, that the relative definiteness of instinctive responses has been subjected to criticism from a psychological source. It has been urged that the nutritive instincts, the play instincts, the parental instincts, those of self-preservation and those concerned in reproduction, are so varied and multifarious, that definiteness is the last thing that can be predicated of them. Varied and multifarious they are indeed; and each of the groups above mentioned contains many differing examples. But that is because we are dealing with comprehensive classes of instinctive behaviour. The fact that the group of fishes includes organisms of such wide structural diversity, as the salmon, the globe-fish, the eel, and the sole, does not affect the fact that these species have a relatively definite structure each after his kind. It is only when we treat a group of fishes as if it were an individual fish that we are troubled by indefiniteness of structure. And it is only when we deal with a group of instincts, comprised under a class-name, as if it were a particular instinctive act, that we fail to find that definiteness which, to the naturalist, is so remarkable.

From the physiological point of view, instinctive procedure would seem to have its origin in an orderly group of outgoing neural discharges from the central office of the nervous system giving rise to a definite set of muscular contractions. And this appears to have an organic basis in a congenital preformation in the nervous centres, the activity of which is called into play by incoming messages, both from internal organs in a state of physiological need, and from the external world through the organs of special sense. The naturalist fixes his attention chiefly on the visible behaviour which is for him the essential feature of the instinctive act. But in view of the requirements of psychological interpretation it is advisable to comprise under the term instinct, in any particular manifestation of its existence, the net result of four things: first, internal messages giving rise to the impulse; secondly, the external stimuli which co-operate with the impulse to affect the nervous centres; thirdly, the active response due to the coordinated outgoing discharges; and fourthly, the message from the organs concerned in the behaviour by which the central nervous system is further affected. Now I shall here assume, without pausing to adduce the arguments in favour of this view, that consciousness is stirred in the brain, only by incoming messages. If this be so, the outgoing discharges which produce the behaviour are themselves unconscious. Their function is to call forth adaptive movements; and these movements give rise to messages which, so to speak, afford to consciousness information that the instinctive act is in progress. Hence I have urged that the instinctive *performance* is an organic and unconscious matter of the purely physiological order, though its effects are quickly communicated to consciousness in the form of definite messages from the motor organs. I have not denied that the stimuli of sight, touch, hearing and so forth, also have conscious effects; I do not deny (though here I may have spoken too guardedly) that the initiating impulse of internal origin, is conscious. In both these cases we have messages transmitted to the central office of the brain. What I have ventured to urge is that the consciousness of instinctive behaviour, *in its completed form*, does not arise until further messages come in from the motor organs implicated in the performance of the act, lodging information at the central office concerning the nature of the movements.

A diagram will perhaps serve to make this conception clearer.



The circle represents the brain, in some part of which consciousness arises through the effects of incoming nerve-currents. Under the influence of the two primary groups of messages, due to impulse and to sensory stimulus, consciousness is evoked, and the brain is thrown into a state of neural strain, which is relieved by the outgoing discharge to the organs concerned in the instinctive behaviour. It is this outgoing discharge which I regard as unconscious. But the actions which are thus produced give rise to a secondary group of incoming messages from the moving limbs. This it is which gives origin to the consciousness of instinctive behaviour as such. And I regard it as psychologically important that these incoming messages are already grouped, so as to afford to consciousness information, rather of the net results of movement than of their subsidiary details.

So much for our general scheme. If now we turn to the instinctive behaviour concerned in locomotion, we find a congenital basis upon which the perfected activities are founded. There is no elaborate process of learning to walk on the part of the chick; ducklings and moorhens a few hours old swim with perfect ease when they are placed in water; these birds also dive without previous practice or preliminary abortive attempts; while young swallows, if their wings are sufficiently large and strong, are capable of short and guided flights the first time they are committed to the air. In these cases neither the internal impulse, nor the sensory stimuli, are so well defined as in the case of the nutritive activities. The impulse probably takes the

form of an uneasy tendency to be up and doing, perhaps due to ill-defined nervous thrills from the organs of locomotion which are in need of exercise. The sensory stimuli are presumably afforded by the contact of the feet with the ground, or with the water, and by the pressure of the air on the wing-surfaces. It is a curious fact that, if young ducklings be placed on a cold and slippery surface, such as that of a japanned tea-tray, they execute rapid scrambling movements, suggestive of attempts to swim, which I have never seen in chicks, pheasants, or other land-birds.

It will not be supposed that I claim for perfected locomotion, so admirably exemplified in the graceful and powerful flight of birds, an origin that is wholly instinctive and unmodified by the teachings of experience. Here as elsewhere instinct seems to form the ground-plan of activities which intelligence moulds to finer and more delicate issues. This is the congenital basis on which is built the perfected superstructure. And if our opportunities for observation, and our methods of analysis, were equal to the task, we should be able to distinguish, in the development of behaviour, the congenital outline from the shading and detail which are gradually filled in by the pencil of experience.

The difficulties which render this analysis at the best imperfect are, therefore, twofold. In the first place, intelligence begins almost at once to exercise its modifying influence; and in the second place, many instinctive traits do not appear until long after intelligence has begun its work. Much of the intelligent detail of the living picture is filled in before the instinctive outlines are complete. The term "deferred instincts" has been applied to those congenital modes of procedure which are relatively late in development. The chick does not begin to scratch the ground, in the manner characteristic of rasorial birds, till it is four or five days old; nor does it perform the operation of sand-washing till some days later; the moorhen does not begin to flick its tail till it is about four weeks old; the jay does not perform the complex evolutions of the bath till it has left the nest and felt its legs, when the stimulus of water to the feet, and then the breast, seems to start a train of acts which, taken as a whole, are of a remarkably definite type. The development of the reproductive organs brings with it, apart from the act of pairing, a number of associated modes of behaviour—nest-building, incubation, song, dance, display, and strange aerial evolutions—which are presumably in large degree instinctive, though of this we need more definite evidence. For it is difficult to estimate with any approach to accuracy the influence of imitation. There seems to be no reason for doubting that, when an animal grows up in the society of its kind, it is affected by what we may term the traditions of its species, and falls into the ways of its fellows, its imitative tendency being subtly influenced by their daily doings. The social animal bears the impress of the conditions of its peculiar nurture. Its behaviour is in some degree plastic, and imitation helps it to conform to the social mould.

The exact range and nature of the instinctive outline, independently of those modifications of plan which are due to the inherent plasticity of the organism, are, therefore, hard to determine. And if, as we have good grounds for believing, the growth of intelligent plasticity, in any given race, is associated with a disintegration of the instinctive plan, congenital adaptation being superseded by an accommodation of a more individualistic type, to meet the needs of a more varied and complex environment, the problems with which we have to deal assume an intricacy which at present defies our most subtle analysis.

We must now turn to the consideration of the manner in which individual accommodation through the exercise of intelligence under the teachings of experience, is brought about. And it will be well to pave the way by adducing certain facts of observation.

Although the pecking of a young chick under the joint influence of hunger and the sight of a small near object, would seem to belong to the instinctive type, the selection of appropriate food, apart from the natural guidance of the hen, seems to be mainly determined by individual experience. There is no evidence that the little bird comes into the world with anything like hereditary knowledge of good and evil in things eatable. Distasteful objects are seized with not less readiness than natural food such as grain, seeds, and grubs. The conspicuous colours of certain nasty caterpillars do not appeal to any inherited power of immediate discrimination so as to save the bird from bitter experience. They seem rather to serve the purpose of rendering future avoidance, in the light of this bitter experience, more ready, rapid, and certain. Bees and wasps are seized with neither more nor less signs of fear than large flies or palatable insects. Nor does there seem to be any evidence of the hereditary recognition of natural enemies as objects of dread. Pheasants and partridges showed no sign of alarm when my dog quietly entered the room in which they were kept. When allowed to come to closer quarters, they impudently pecked at his claws. A two days chick tried to nestle down under him. Other chicks took no notice of a cat, exhibiting a complete indifference which was not reciprocated. A moorhen several weeks old would not suffer my fox-terrier to come near his own breakfast of sopped biscuit, but drove him away with angry pecks until the higher powers supervened.

It is not, of course, to be inferred from these observations that such an emotion as fear has no place in the hereditary scheme, or that the associated acts of hiding, crouching, or efforts to escape do not belong to the instinctive type. I have seen little pheasants struck motionless, plovers crouch, and moorhens scatter at the sound of a loud chord on the violin, or of a shrill whistle. A white stoneware jug, placed in their run, caused hours of uneasiness to a group of birds, including several species. But there is no evidence that, in such cases, anything like hereditary experience defines those objects which shall excite the emotion. It is the unusual and unfamiliar object, especially after some days of active life amid surroundings to which they have grown accustomed; it is the sudden sound, such as a sneeze, or rapid movement, as when a ball of paper is rolled towards them, that evokes the emotion. Hence, if the parent birds are absent, the stealthy approach of a cat causes no terror in the breasts of inexperienced fledglings. But when she leaps, and perhaps seizes one for her prey, the rest scatter in alarm, and for them the sight of a cat has in the future a new meaning.

The elementary emotions of fear, anger, and so forth, stand in a peculiar and special relationship to instinct. At first sight they seem to take rank with the internal impulses which are the part-determinants of instinctive behaviour. The crouching of a frightened plover or landrail, the dive of a scared moorhen, result partly from the external stimulus afforded by the terrifying object, partly from the emotional state which that object calls forth. But in their primary genesis I am disposed—here following to some length the lead of Prof. Wm. James—to assign to such emotions an origin similar to that of the consciousness which follows on the execution of the instinctive act. Assuming, as before, that consciousness owes its genesis to messages which reach the sensorium through incoming nerve-channels, the sensory stimuli, afforded, let us say, by the sight of a terrifying object, do not seem, in the absence of inherited experience, capable of supplying messages which in themselves are sufficient to generate the emotion of fear. Now, the well-known accompaniments of such an emotional state are disturbances of the heart-beat, the respiratory rhythm, the digestive processes, the action of the glands, and the tone of the minute blood-vessels throughout the body. And all these effects are unquestionably *produced* by outgoing discharges from the central nervous system. But they are *felt* as the result of incoming messages, like vague and disquieting rumours, transmitted to the central office from the fluttering heart, the irregular breathing, the sinking stomach, and the disturbed circulation. Is it not therefore reasonable to suppose that the emotion, in its primary genesis, is due to the effect on the sensorium of these disquieting messages? If this be admitted as a working hypothesis—and it cannot at present claim to be more than this—we reach, at any rate, a consistent scheme. As primary messages to the central office of consciousness we have, on the one hand, those due to stimuli of the special senses, and, on the other hand, those resulting from the conditions of the bodily organs, taking the form of a felt craving for their appropriate exercise. These co-operate to throw the brain into a state of unstable equilibrium or neural strain, which is relieved by outgoing streams of nervous energy. And these in turn fall into two groups; first, an orderly set of discharges to the voluntary muscles concerned in behaviour, and secondly, a more diffuse group of discharges to the heart, respiratory apparatus, digestive organs, glands, and vascular network. In so far as these are outgoing discharges, they do not directly affect consciousness. But there quickly returns upon the sensorium an orderly group of incoming messages from the motor apparatus concerned in instinctive behaviour, and a more indefinite group from the heart and other visceral

organs. The former gives the well-defined consciousness of activity; the latter the relatively ill defined feelings which are classed as emotional. But so swift is the backstroke from the body to the brain that, ere the instinctive behaviour is complete, messages from the limbs—and, under the appropriate circumstances, from the heart—that is to say, of both instinctive and emotional origin—begin to be operative in consciousness, and the final stages of a given performance may be guided in the light of the experience gained during its earlier stages.

The exact manner in which consciousness exercises its guiding influence, is a matter of speculation. Perhaps the most probable hypothesis is that the cerebral hemispheres are an adjunct to the rest of the central nervous system, and exercise thereon by some such mechanism as the pyramidal tract in the human subject, a controlling influence. Given an hereditary ground-plan of automatic and instinctive responses the cerebral hemispheres may, by checking here and enforcing there, limit or extend the behaviour in definite ways. In any case, from the psychological point of view, their action is dependent on three fundamental properties: first, the retention of modifications of their structure; secondly, differential results according as these modifications have pleasurable or painful accompaniments in consciousness; and thirdly, the building of the conscious data, through association, into a system of experience. The controlling influence of this experience is the essential feature of active intelligence. Or, expressed in the almost obsolete terminology of the older psychology, intelligence is the faculty through which past experience is brought to bear on present behaviour.

Prof. Stout, whose careful work in analytical psychology is well known, has done me the service of criticising, in a private communication, my use of the phrase "past experience," urging that present experience is not less important in determining behaviour than that which is past and which can only be operative through its revival in memory. The criticism is valid in so far as it shows that I have not been sufficiently careful to define what I mean by past experience. But I certainly had in mind, though I did not clearly indicate, the inclusion of what Mr. Stout regards as present experience. My conception of "present," as I have elsewhere described it, is that short but appreciable period of time, occupying only some small fraction of a second, which is comprised in the fleeting moment of consciousness. All anterior to this, if it were but a second ago, I regard as past—past, that is to say, in origin, though still operative in the limited field of the present moment. When we are reading a paragraph and near its close, the net result of all that we have read in the earlier sentences, is present to influence the course of our thought. But the very words—"all that we *have* read"—by which we describe this familiar fact, imply that the guiding experience originated in a manner which demands the use of the past tense. Still I am none the less grateful to Mr. Stout for indicating what to many may have seemed a serious omission in my interpretation. Suffice it to say that if we include under the phrase "present experience" the occurrences of five minutes, or even of five seconds ago (all of which I regard as past), I most fully agree that present experience (in this sense) exercises a most important guiding influence.

We have distinguished four classes of messages affecting consciousness in the central office of the sensorium: first, stimuli of the special senses; secondly, internal cravings; thirdly, motor sensations due to bodily activity; and fourthly, emotional states. These are combined in subtle synthesis during the growth of experience, and are associated together in varied ways. Into the manner in which experience grows we cannot enter here. It will be sufficient to indicate very briefly the effects of this growth on the behaviour of animals in the earlier stages of their life. This may be considered from a narrower or from a broader standpoint. In the narrower view we watch how, within the field of a widening synthesis, the particular associations are formed. We see how, within experience, the taste and appearance of certain caterpillars or grubs become so associated that for the future the larva is left untouched. Or we see how the terrible pounce of the cat has become so associated with her appearance as thenceforth to render her an object of fear to enlightened sparrows. But of the physiological mechanism of association we know little.

There is a familiar game in which a marble is rolled down an inclined board at the bottom of which are numbered compartments. The lower part of the board is beset with a series of vertical pins so arranged that the marble rebounding from one to another pursues a devious course before it reaches its destination. But if we tie threads from pin to pin we may thus direct the course of the marble along definite lines. Now the brain may be roughly likened to a set of such pins, and the marble to an incoming nerve current. The congenital structure is such that a number of hereditary threads connect the pins in definite ways, and direct the discharge into appropriate channels. But a vast number of other threads are acquired in the course of individual experience. These are the links of association which direct the marble in new ways. Observation of behaviour can only give us information that new directing threads have been introduced. The psychology of association can only indicate which pins have been connected by linking threads. Even such researches as those of Flechsig can at present do no more than supplement the psychological conclusion by general anatomical evidence. Of the details of brain modification by the formation of association fibres we are still profoundly ignorant.

Nor when we turn from the narrower to the wider point of view are we in better case. We are forced to content ourselves with those generalities which are the makeshift of imperfect knowledge. Still, even such generalities are of use in showing the direction in which more exact information is to be sought. And we can, perhaps, best express the net result of acquired modification of brain-structure by saying that every item of experience makes the animal a new being with new reactive tendencies. The sparrows, which yesterday were unaffected by the stealthy approach of the cat, garrulously scatter to-day because they are not the same simple-minded sparrows that they were. The chick comes into the world possessed of certain instinctive tendencies—with certain hereditary directing threads. But at the touch of experience its needs are modified or further defined. New connecting threads are woven in the brain. On the congenital basis has been built an acquired disposition. The chick is other than it was, and reacts to old stimuli with new modes of behaviour.

In its early days the developing animal is reading the paragraph of life. Every sentence mastered is built into the tissue of experience, and leaves its impress on the plastic, yet retentive brain. By dint of repetition, the results of acquisition become more and more firmly ingrained. Habits are generated; and habit becomes second nature. The organism which to begin with was a creature of congenital impulse and reaction becomes more and more a creature of acquired habits. It is a new being, but one with needs not less imperious than those with which it was congenitally endowed.

All of this is trite and familiar enough. But it will serve its purpose if it help us to realise how large a share acquired characters take in the development of behaviour in the higher animals, and how fundamentally important is the plasticity of brain-tissue, and its retentiveness of the modifications which are impressed on its yielding substance.

Such being the relations of intelligence and instinct in the individual, what are their relations in the evolution of the race? Granting that instinctive responses are definite through heredity, how has this definiteness been brought about? Has it been through natural selection? Or are the acquired modifications of one generation transmitted through heredity to the next? Is instinct inherited habit? Darwin, who wrote before the transmission of acquired characters was seriously questioned, admitted both. And Romanes, to whose ever-kindly sympathy I am deeply indebted, still adhered to this view in spite of modern criticism. There is not much in my own observational work which has any decisive bearing on the question. But there are one or two points which are perhaps worthy of consideration. The part played by acquisition in the field of behaviour is the establishment of definite relations between particular groups of stimuli and adaptive responses. If this be so, and if acquired modifications of brain-structure be transmitted, we might reasonably expect that the sight of a dog would have a similar effect on young pheasants to that which it has on their parents. But this does not appear to be the case. Again, one might reasonably expect that the sight of water would evoke a drinking response in recently hatched birds, just as the sight or scent of a Yucca flower excites a definite response in the Yucca moth. But here, too, this is not so. Thirsty chicks and ducklings seem to be uninfluenced by the sight of water in a shallow tin. They may even run through the liquid and remain unaffected by its presence. But if they chance to peck at a grain at the bottom of the tin, or a bubble on the water, as soon as the beak touches the liquid, *this* stimulus at once evokes a drinking response again and again repeated. Why does the touch of

water in the beak excite a congenital response, while the sight of water fails to do so? I believe it is because under natural conditions the chicks peck at the water in imitation of the mother, who thus shields them from the incidence of natural selection. Under these circumstances there is no opportunity for the elimination of those who fail to respond at the mere sight of water, and consequently no selective survival of those who do thus respond. But though the hen can lead her young to peck at the water, she cannot teach them the essential movements of beak, mouth, and gullet, which are necessary for the complex act of drinking. In this matter she cannot shield them from the incidence of natural selection. Those which, on pecking the water, failed to respond to the stimulus by drinking, would assuredly die of thirst and be eliminated. The rest would survive and transmit the congenital instinctive tendency. Thus it would seem that when natural selection is excluded a special mode of behaviour has not become congenitally linked with a visual stimulus; but, when natural selection is in operation, this behaviour has become so linked with a touch or taste stimulus in the beak, Similarly in the case of the pheasants and the dog. The parent birds warn the young of his approach, and thus prevent the incidence of natural selection. Hence there is no instinctive response to the sight of a terrier.

No doubt there are many cases of complex behaviour, seemingly instructive, which are difficult to explain by natural selection alone, and which have the appearance of being due to the inheritance of acquired habits. I have, however, elsewhere suggested that acquired modifications may, under the conditions of natural selection, foster the development of "coincident" variations of like nature and direction, but having their origin in the germinal substance. But into a consideration of this hypothesis I cannot here enter. Without assuming a dogmatic attitude, I am now disposed to regard the direct transmission of acquired modes of behaviour as not proven.

Thus we come back to the position, assumed at the outset, that heredity plays a double part It provides, through natural selection or otherwise, an outline sketch of relatively definite behaviour, racial in value; it provides also that necessarily-indefinite plasticity which enables an animal to acquire and to utilise experience, and thus to reach adaptation to the circumstances of its individual life. It becomes, therefore, a matter of practical inquiry to determine the proportion which the one kind of hereditary legacy bears to the other. Observation seems to show that those organisms in which the environing conditions bear the most uniform relations to a mode of life that is relatively constant, are the ones in which instinct preponderates over intelligent accommodation; while those in which we see the most varied interaction with complex circumstances, show more adaptation of the intelligent type. And the growth of individual plasticity of behaviour, in race-development, would seem to be accompanied by a disintegration of the definiteness of instinctive response, natural selection favouring rather the plastic animal capable of indefinitely varied accommodation than the more rigid type whose adaptations are congenitally defined.

I have dealt, it will be observed, only with the lower phases and earlier manifestations of intelligence. Its higher development, and the points in which it differs from the more complex modes of human procedure, offer a wide and difficult field for careful observation and cautious interpretation. I have recently attempted further investigations in this field; but they concern rather the relation of intelligence to logical thought than that of instinct to intelligence, which forms the subject of this discourse.

THE DUKE OF DEVONSHIRE ON TECHNICAL EDUCATION.

AT Eastbourne on Saturday last the Duke of Devonshire addressed the students of the art and technical classes, and in the course of his remarks he referred to educational questions of more than local interest. His remarks upon proprietary and private schools call attention to what is probably the weakest link in our educational system. In order to qualify for an assistant mastership in an elementary school, it is necessary for a teacher to serve a term of years, during which period his knowledge of the theory and practice of teaching is periodically tested; but in our private and proprietary schools any one can be a teacher, whether he possesses qualifications or not. In other words, the elementary school teacher must prove his efficiency, while the teacher in the middle-class schools—the respectable proprietary establishments—may or may not be competent to impart instruction. The result is that some of our higher-grade primary schools are the best organised and equipped institutions for teaching elementary science in the country, while the science which figures in the prospectuses of many private schools is entirely unworthy of the name. Unfortunately, the sons of artisans and shopkeepers are compelled to leave school at an early age, and so cannot take full advantage of the facilities provided by the higher-grade schools. On the other hand we have the private schools where the age of leaving is later, but there the facilities for scientific instruction are inadequate. The general result is that only a small proportion, either of the artisan class or of the sons of commercial men, receive technical instruction. It is, of course, not suggested that all private schools are inefficient, but a large proportion of them are, when considered as schools in which science is taught; and the Duke of Devonshire has done a public service in pointing out the need of subjecting them to some system of supervision.

The following is abridged from the *Times* report of the Duke of Devonshire's address:—

PROPRIETARY AND PRIVATE SCHOOLS.

I suppose that there are in Eastbourne a larger number of proprietary and private schools than in almost any other town of the same size in the country. It would be extremely interesting to have full information as to what these schools are doing and the nature of the instruction which they provide. I doubt very much whether there is any one here, or whether there is anybody anywhere, who has the means of forming or giving a complete account of what the proprietary and private schools of any particular district in the country are doing, or what is the nature of the instruction which they are providing. That appears to me to point to the need for some better organisation of education than we at present possess. Of the students who are receiving their education in the numerous proprietary schools here and in other similar schools in the country there are many, no doubt, whose future would not be dependent upon their own exertions, and who are only educating themselves, or being educated by their parents, to make them good citizens and cultivated people; but there must be a very large number in addition who are looking forward to entering into some profession or another, or into some branch of industry or of commerce. And to the parents of such students it would be of immense value and importance to have full knowledge and full information upon the character of the education which is being given at these proprietary and private schools. Some of them, no doubt, are more efficient; some are less efficient than others; but, even amongst those which are the most efficient, there must be some which are capable of giving a more valuable hint and direction of instruction to those who are going to enter upon industrial and commercial pursuits than those which may be in other directions equally efficiently organised; and it would be of the very greatest importance, in my opinion, to the schools themselves, to the parents, and to the community at large if means were at our disposal to know more of the manner in which these schools are organised and of the work which they are doing.

TECHNICAL EDUCATION ABROAD.

Foreign nations have anticipated us to a very great extent in realising the close connection which exists between education and industrial and commercial success. That is a fact which is being brought home to us almost daily in various directions of the increasing competition to which we find ourselves in every quarter exposed. It is a subject which, as your chairman has reminded you, I have frequently discussed on previous occasions, and I am not going to enter into it at any length again to-night. I will only say that the urgency of this question is now recognised by those who are educational experts or educational enthusiasts. The urgency of the question is coming to be recognised by practical men of business. Only the other day the education authority of Manchester sent out a deputation of its members to ascertain what provision was being made in Germany and Switzerland for the industrial and commercial education of the people. They published a most valuable report, in which they spoke almost with dismay of the completeness with which the education of those who were leading and directing the manufacturing and commercial enterprise of those countries was being organised; and they urged upon their fellow-citizens, in the very strongest terms, that they should not allow themselves to be left behind in the race, but that they should make an effort for the organisation of the education of

their own people to bring that education up to something like the level which has been attained in those countries. And the Associated Chambers of Commerce the other day presented a memorial, a most important memorial, to the Government urging upon them that greater attention should be paid by the educational departments of the State, not to art and scientific instruction only, but to the study of foreign languages and other subjects indispensable to the successful prosecution of a commercial career. And therefore I say it is not educational enthusiasts only, but it is practical and far-headed men of business who are beginning to realise the absolute necessity of bringing up our education somewhere near, at all events, to the levels which have been attained in other countries.

ORGANISATION OF SECONDARY EDUCATION.

I have not the smallest desire to see our secondary education modelled upon one uniform pattern. I believe that we require great variety and great freedom, but I do think that it would be of advantage if both central and local organisations existed with which these private institutions might place themselves in voluntary, but, at the same time, in close connection—organisations which, by means, perhaps, of inspection, by their guidance, and by their counsel—might enable them so to organise themselves, so to co-relate themselves, as to render the instruction which they may give more valuable to the public. These are, of course, observations of a very general character, which, if they have any substance, apply equally to schools in every part of the country. Speaking of this particular district—of your own schools—I cannot help thinking that it might be of great advantage, both to them and to the community of Eastbourne, if, under the county educational authority or under your borough educational authority—there ought not to be any jealousy between different bodies of that kind—there could be established in this town of Eastbourne a scientific and technical institute, which might be of great value to the inhabitants of Eastbourne itself and also of great assistance to those educational establishments which are so numerous amongst you, and which might make use of such establishments as part of their educational course.

PRIZE SUBJECTS OF THE PARIS ACADEMY OF SCIENCES.

THE *Comptes rendus* of the Paris Academy of Sciences, for January 10, contains the list of subjects proposed for the various prizes offered by the Academy for 1898 and three succeeding years.

For the year 1898, the subject for the Grand Prize of the Mathematical Sciences is to examine and extend the part played by divergent series in analysis; for the Bordin Prize (3000 fr.), to study the questions relating to the determination, properties, and applications of systems of orthogonal curvilinear coordinates of *n* variables, indicating especially the degree of generality of these systems; the Francœur Prize (1000 fr.) and Poncelet Prize (2000 fr.), for the most useful work in the field of pure or applied mathematics. In Mechanics, the Extraordinary Prize of 6000 fr., for progress in any direction calculated to increase the efficiency of the French naval forces; the Montyon Prize (700 fr.), for inventing or improving instruments useful to the progress of agriculture, the mechanical arts or sciences; the Plumey Prize (2500 fr.), for improvements in steam engines, or any other invention contributing to the progress of steam navigation; the Fourneyron Prize (500 fr.), for the theory of the motion of bicycles, discussing more especially the conditions of stability of both rectilinear and curved motion on a horizontal or inclined plane.

In Astronomy, the Lalande Prize (540 fr.), for the most interesting observation, or the work or memoir most useful to the progress of astronomy; the Damoiseau Prize (1500 fr.), for an exposition of the theory of the perturbations of Hyperion, the satellite of Saturn, taking account principally of the action of Titan, comparing the observations with the theory, and hence deducing the mass of Titan; the Valz Prize (460 fr.), for the most interesting astronomical observation made during the current year; the Janssen Prize (a gold medal), for discoveries in physical astronomy.

In Statistics, the Montyon Prize (500 fr.), for questions relating to French statistics; and in Chemistry, the Jecker Prize (10,000 fr.), for work in organic chemistry.

In Mineralogy and Geology, the Vaillant Prize (4000 fr.), for a work discussing and making known the indications furnished by the microscopical study of sedimentary rocks (particularly secondary and tertiary) from the point of view of their genesis and of the modifications which they have undergone since their deposit in structure and composition, organised bodies being included.

In Botany, the Barbier Prize (2000 fr.), for discoveries bearing upon the art of healing; the Desmazières Prize (1600 fr.), for the best study of Cryptogams; the Montagne Prizes (1000 fr. and 500 fr.), for memoirs bearing on the anatomy, physiology, and development of the lower Cryptogams; the De la Fons-Melicocq (900 fr.), for botanical work on the North of France; and the Thore Prize (200 fr.) to the author of the best work on the cellular Cryptogams of Europe.

In Anatomy and Zoology, the Savigny Prize (975 fr.), for the assistance of young travelling zoologists, not receiving Governmental support, who have specially occupied themselves with the invertebrate fauna of Egypt and Syria.

In Medicine and Surgery, a Montyon Prize for discoveries or inventions bearing on medicine or surgery; the Barbier Prize (2000 fr.), for the most valuable discovery in relation to the art of healing (surgery, medicine, pharmacy or botany); the Bréant Prize (100,000 fr.), for a discovery leading to the complete suppression of Asiatic cholera; the Godard Prize (1000 fr.), for the best memoir on the anatomy, physiology, and pathology of the genito-urinary organs; also the Bellion (1400 fr.); Mège Lallemand (1800 fr.), and Baron Larrey Prizes.

In Physiology, a Montyon Prize (750 fr.); the Pourat Prize (1400 fr.), for a memoir on the motor nerves of the stomach, and the Philipeaux Prize (890 fr.).

In Physical Geography, the Gay Prize (2500 fr.), for a comparison between the marine flora of the Bay of Biscay with that of neighbouring regions and of the Mediterranean; also to see if the fauna and flora lead to similar conclusions. Other general prizes offered are the Arago Medal, the Montyon Prize (unhealthy trades), the Trémont Prize (1100 fr.), the Gegner Prize (4000 fr.), the Delalande-Guérineau Prize (1000 fr.), the Jérome Ponti Prize (3500 fr.), the Leconte Prize (50,000 fr.), for a new and important discovery in mathematics, physics, chemistry, natural history, or medical science; the Tchiatcheff Prize (3000 fr.), for exploration of the lesser-known portions of Asia; the Houllevigue Prize, the Cahours Prize (3000 fr.), for the assistance of young chemists of promise; the Saintour Prize (3000 fr.), the Kastner-Boursault Prize (2000 fr.), for the best work on the applications of electricity in the arts, industry, and commerce; and the Estrade-Delcros Prize (8000 fr.).

Of these prizes, those of Montagne and Delalande-Guèrineau are expressly restricted to Frenchmen, whilst the Lalande, La Caze, Delesse, Desmazières, Tchiatcheff, and Leconte Prizes are awarded without distinction of nationality.

MR. CAVENDISH ON HIS JOURNEY TO LAKE RUDOLF.

ON Monday last, Mr. H. S. H. Cavendish described his recent journey in East Africa before the Royal Geographical Society. Accompanied by Lieut. H. Andrew, Mr. Cavendish left Berbera on September 5, 1896, and proceeded in a southerly direction to Lugh, on the Juba River, afterwards striking westwards up the Dau. Here it proved very difficult to get into communication with the natives, as the caravan was at first taken for an Abyssinian force. The country of the Boran Gallas, with whom Dr. Donaldson Smith had so much trouble, was, however, soon reached. Mr. Cavendish gave some interesting details respecting this tribe, which he found most friendly, and anxious to be placed under British protection. Whilst in the Boran country the travellers were able to wander about at will without escort. At Egder, in about lat. 4° N., long. 39° E., Dr. Donaldson Smith's route was left, and the caravan made direct for Lake Stefanie, passing a remarkable crater with a lake at the bottom, from which salt is obtained. At the south end of Lake Stefanie a large outcrop of coal was discovered, which had evidently been laid bare by the action of the water. It was in this neighbourhood that Mr. Cavendish had an adventure with an elephant which well-nigh proved fatal. Some valuable information was collected with regard to the tribes on the western side of the lake, the principal of which are the Wanderobo (allied to the Borans), the Harbora, Hamerkoke (nomads), and Galubba. Striking across to the north end of Lake Rudolf, the travellers reached the country of the Reshiat or Darsonich, a race of traders, but, like other tribes of the

country, almost entirely unclothed. A remarkable weapon in use among them is a kind of knife-bracelet, which is covered with a sheath, except during a fight.

The two Europeans now separated, Mr. Cavendish proceeding northwards to explore the river flowing into the north end of Lake Rudolf, whilst Lieut. Andrew marched down the east side of the lake. Like Captain Bòttego, Mr. Cavendish is confident that the river, which he followed up for some distance, is identical with the Omo of travellers in the south of Abyssinia. The Legumi and Murle, who dwell on its banks, wear caps of human hair, into which ostrich feathers are stuck to denote the number of men killed by the wearer. The Murle also use the wrist-knife above described, as well as a kind of battle-axe with a wooden blade, covered with a tightly-stretched skin. Crossing the Omo, Mr. Cavendish proceeded southwards to the country of the Turkana on the west of Lake Rudolf, which had previously been entered by no travellers except the members of Bòttego's expedition. Mount Lubur, an extinct volcano, was here ascended. The crossing of a sort of neutral zone at the border of the Turkana country is taken as a declaration of war, and the caravan was in consequence continually harassed by attacks from this warlike people. They are in the habit of making night attacks, and it was only by camping each night on spits of sand running out into the lake that these were successfully resisted. Finally friendly relations were established, and the Turkana guided the party through the difficult mountainous country towards the south. At the south end of Lake Rudolf Mr. Cavendish found that the Teleki volcano had entirely disappeared, the Ligob who dwelt in its neighbourhood telling him that, six months before, the lake had overflowed, and as the waters rushed towards the mountain there was a great explosion, since which a lava-plain has taken the place of the volcano, while a new crater has opened about three miles further south. The whole country seems to show signs of recent volcanic activity, for on the further march to the south, the caravan being once more united, a new lake was discovered containing a smouldering volcano, near which the water was quite hot to the touch. Where the water had dried up, the lake-bed was of black mud, hard on the surface, but hot and liquid below. Beyond this the country was exceedingly difficult, and water was scarce; but the caravan finally reached Lake Baringo, and thence made its way through known country to the east coast.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. E. W. Hobson, F.R.S., has been appointed a Governor of Derby School.

The original researches of Mr. J. A. McClelland, advanced student of Trinity College, have been approved by the Special Board for Physics and Chemistry as a qualification for the B.A. degree. Mr. McClelland's papers refer to work on the kathode, Lenard, and Röntgen rays.

Eighteen additional freshmen, including one advanced student, were matriculated on January 28.

MR. W. R. LANG has been appointed lecturer on organic chemistry at Glasgow University.

MR. PERCY A. HILLHOUSE has been appointed professor of naval architecture in the Imperial University, Tokio.

THE Cameron Prize of the University of Edinburgh, open each year to any one who in the preceding five years has made any "highly important and valuable additions to practical therapeutics," has (says the *British Medical Journal*) been awarded to Prof. T. R. Fraser, F.R.S., in recognition of his researches and practical therapeutic observations in connection with strophanthus.

THE fifth annual meeting of the Association of Technical Institutions was held on Friday last. Sir Bernhard Samuelson, Bart., who was elected president of the Association for the year 1898, delivered an address on the need of organised technical instruction. Resolutions were passed in favour of a system of examination and diplomas suitable more especially for day students who aspire to take leading positions in the various technical industries; and urging upon the Department of Science and Art the necessity of modifying the recent circular respecting the proportion of students who continue their studies in Schools of Science.

THE report of the Board of Agriculture on the distribution of the Parliamentary grant in aid of agricultural education in Great Britain during the year 1896–7 shows that sums amounting to a total of 6950*l*. were distributed in specific grants to fourteen institutions as follows:—Durham College of Science, Newcastle-on-Tyne, 1000*l*.; University College of North Wales, Bangor, 800*l*.; Yorkshire College, Leeds, 800*l*.; University College of Wales, Aberystwyth, 800*l*.; Reading University Extension College, 800*l*.; Nottingham University College, 600*l*.; Cambridge and Counties Agricultural Education Committee, 500*l*.; South-Eastern Agricultural College, Wye, 400*l*.; Eastern Counties Dairy Institute, Ipswich, 300*l*.; British Dairy Institute, Reading, 300*l*.; Bath and West and Southern Counties Society, 300*l*.; Royal Botanic Garden, Edinburgh, 150*l*.; Highland and Agricultural Society, 100*l*.; Agricultural Research Association, Aberdeen, 100*l*. The *Record of Technical and Secondary Education* states that in addition to the distribution of these sums, the Board have also undertaken the inspection of the agricultural work of the institutions and bodies assisted, as well as that of seven County Councils. A valuable feature of the report is the detailed information given regarding the agricultural instruction provided by the English and Welsh County Councils. From statistics compiled from this Return, it appears that a total sum of over 80,000*l*. (including a proportion of capital expenditure) was devoted during 1896–7 to agricultural instruction by sixty English and Welsh County Councils. Dairy instruction was taught in all but eight English and Welsh counties, and the manual processes of agriculture in about one-half the English counties.

AT the meeting of the London County Council on Tuesday, the Technical Education Board submitted an estimate of the amount that should be appropriated for technical education during the year 1898–99. The sum of 150,000*l*. was granted for the year 1896–97, and of this a balance of 13,384*l*. was unexpended. For the year ending March 31, 1899, it is estimated that 170,000*l*. will be required, in addition to this balance. The amount of the estimated expenditure is arrived at as follows:—For technical departments of polytechnics, 35,900*l*.; for various technical institutes, 36,000*l*.; for technical departments of public secondary day schools and allowance for fees, books, &c., of the Board's county scholars, 28,500*l*.; for higher education, 5500*l*.; for county scholarships, 31,025*l*.; for teaching in art, science, and technology and manual instruction, 27,800*l*.; for domestic economy, 7350*l*.; for commercial subjects, 3300*l*.; for museums (chiefly art examples), 1500*l*.; and for expenses of administration, 7300*l*. In a tabular statement the Board gives since the year 1890 the amount of the Exchequer contribution from beer and spirit duties, out of which the grant for technical education is made. From this it appears that the amount now asked for technical education, 170,000*l*., will absorb almost the whole of the amount which the Council will receive from the beer and spirit duties, which is estimated for the ensuing year at 177,000*l*. The Council's grants towards technical education in London have gradually increased from the year 1892–93, when the grant was only 29,000*l*., up to the present year, when the grant was 150,000*l*. For the ensuing year an additional 20,000*l*. is asked for.

ON Thursday last, at Grocers' Hall, the Speaker distributed the awards gained by students attending the technical colleges and schools which have been established by the City and Guilds of London Institute, under the direct management of its executive committee and maintained out of the funds of the institute contributed by the Corporation and Livery companies of the City of London. In the course of an address to the company, the speaker expressed surprise that more Englishmen did not come forward to fill in their own country posts in which a knowledge of chemistry was required. He confessed that, speaking as an outsider, he did not understand why it was that Germany was not only able to manufacture all the chemists she needed herself, but also to export to different parts of the world fifty chemists for every one who was exported by this country. He ventured to suggest, speaking in all humility, that there was a large field in this direction for the youth of England, if scientifically inclined. He thought it probable that most of those present who were practically acquainted with technical education would agree with him that they had not done nearly as much in this matter—and chemistry was an example of it—as they ought to do and would have to do. A great deal had been done in the past ten or twenty years; but

they began late, and they had not yet caught up some other nations, and much had still to be done in this country in order to provide the facilities that were needed to furnish their sons with the knowledge that was necessary to enable them to carry on the commercial business of the country. The City and Guilds Institute had in the most munificent manner spent on its technical colleges in the course of the past eighteen years about half a million out of the funds over which it had control; but could they go on relying upon private munificence so much as they had done for the purposes of technical education? He ventured to think that the time had come when there should be some system supported by funds, if necessary, of some public nature by which colleges should be founded in the great centres where they were needed, and branch colleges of a similar description in smaller places where they were wanted. The whole scheme of technical education seemed to him to have come to the point at which it required some further consideration. In connection with this subject one had often to speak of Germany and Switzerland, but he was quite sure that they did not speak of them in any spirit of jealousy, but, on the contrary, in a spirit of admiring emulation of their work. They must take what they could that was best from those countries and adopt it, and leave the latter to act in a similar manner towards this country.

SCIENTIFIC SERIALS.

American Journal of Science, January.—A new harmonic analyser, by A. A. Michelson and S. W. Stroud. This is an instrument designed to sum up as many as eighty terms of a Fourier series, or to analyse a given curve into its original series. The pen which traces the curve is worked up and down by a lever controlled by a spring. This spring is stretched by an excentric, which imparts a "simple harmonic" variation to the force. The stretching is resisted by another spring. Eighty such elements are connected together, with one resisting spring to counterbalance the sum of the elementary springs. The pen therefore moves in accordance with the sum of the elementary periodic motions. The authors obtain by this machine the mathematical series representing the profile of a human face.—A new form of physical pendulum, by J. S. Stevens. The error introduced into the ordinary physical pendulum by the fact that the knife-edges and clamp affect the moment of inertia may be eliminated by boring a hole into the rod and screwing the knife edges a little way in, so that they offset the mass of brass bored out.—The Protostegan plastron, by G. R. Wieland. This is a restoration of the plastron of two specimens of the turtle described before as *Archelon ischyros.*—Phosphorescence produced by electrification, by J. Trowbridge and J. E. Burbank. When a piece of fluorspar is first exposed to the action of X-rays, and subsequently heated, it shows a bright phosphorescence. The same phenomenon may be produced by exposing the mineral to an electric brush discharge, and subsequently heating it. It is probable, therefore, that the X-rays produce an electrification of the fluorspar.—On iron meteorites, as nodular structures in stony meteorites, by H. L. Preston. It is an important fact that of over 100 falls and finds of siderites or iron meteorites but nine have been seen to fall, while of the aerolites or stony meteorites of over 400 falls and finds, more than one-half have been seen to fall. The author gives several reasons in support of the view that the siderites are merely the crystallised metallic nodules contained in the larger and more conspicuous stony meteorites.

SOCIETIES AND ACADEMIES.

LONDON.

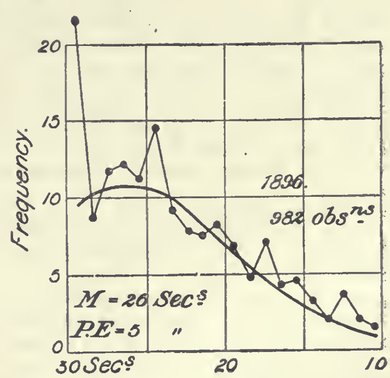
Royal Society, December 13, 1897.—"An Examination into the Registered Speeds of American Trotting Horses, with Remarks on their Value as Hereditary Data." By Francis Galton, D.C.L., F.R.S.

It is strange that the huge sums spent on the breeding of pedigree stock, whether of horses, cattle, or other animals, should not give rise to systematic publications of authentic records in a form suitable for scientific inquiry into the laws of heredity. An almost solitary exception to the disregard shown by breeders and owners, of exact measurements for publication in stud books, exists in the United States with respect to the measured speed of "trotters" and "pacers" under defined conditions. The performance of one mile by a trotter, harnessed to a two-wheeled vehicle, carrying a weight of not less than 150 lbs. inclusive of the driver, in 2 minutes 30 seconds qualifies him for entry in the "Trotting Register," giving him, as it were, a pass-degree into a class of horses whose several utmost speeds or "records" are there published.

The system of timing was first put into practice more than fifty years ago, and has since been developed and improved. In 1892 a considerable change was made in the conditions by the introduction of bicycle wheels with pneumatic tyres, which produced a gain of speed, the amount of which is much discussed, but which a prevalent opinion rates at 5 seconds in the mile. Thenceforward the records are comparable on nearly equal terms. All trotting performances up to the 2′ 30″ standard are registered in the large and closely printed volumes of "Wallace's Year Book," published under the authority of the American Trotting Association. Vols. viii.–xii. refer to the years 1892–6, and it is from the entries in these that the following remarks are based.

The object of my inquiry was to test the suitability of these trotting (and pacing) records for investigations into the laws of heredity. I had to determine whether the observations fell into a tolerably smooth curve; and, if so, whether that curve was a tolerable approach to the normal curve of frequency. In the latter event the observations would fall into line with numerous anthropometric and other measures which have been often discussed, and which, when treated by methods in which the arithmetic mean is employed, yield results that accord with observed facts.

I had 5705 extracts made from the entries published in the Year Books for the five years 1892–6. It was tedious work, and I thought it unnecessary to repeat it to check the results, being satisfied after some examination that they were quite accurate enough for general conclusions. They were arranged in columns; the first to the left contained entries of all observations recorded as 2′ 29·0″, 29¼″, 29½″, or 29¾″; that is of all under 2′ 30″ down to 2′ 29″ inclusive. The second column referred to 2′ 28″·0, 28″¼, 28″½, and 28″¾, and so on with the rest. These were then reduced to percentages and diagrams were drawn from them, of which the following, for the year 1896, is one; it will serve as a fair sample of the other four.



If divided by the eye into imaginary columns corresponding to those in the tables, the point representing the sum of the observations of 2′ 29″·0′, 29″¼, 29″½ and 29″¾ will be found in the middle of the first imaginary column, that is to say it stands vertically above the point that lies half way between 29 and 30 on the scale along the base. The dots are connected by thin lines to show the trace or curve of the observations. The smooth curves are those of normal frequency, calculated from the values of the mean (M) and of the probable error (P.E.), which are given in the diagrams.

Leaving aside for the moment the strange pinnacle that rises on the extreme left of every diagram, we see that the traces of the rest of the observations run very roughly, but not intolerably so. In each diagram they seem to be disposed about a fundamentally smooth curve. Considering the smallness of the interval, namely, only one second, that separates the observations assigned to each pair of successive columns, together with the experience derived from other kinds of statistical curves, it seems to me that the run of the observations is good enough to certify their general trustworthiness. As regards the pinnacle it is different matter, and is one which when beginning work, as

did, on the 1892 entries only, was very perplexing. However, by persevering with the other years, it became increasingly plain that the pinnacle was a false maximum; in 1896 it was certain that the true maximum lay well within the portion of the curve included in the diagram. The explanation of the pinnacle then became obvious [1]; it was that the tolerance granted to those horses who failed by only a little to qualify themselves, was extended considerably beyond the quarter second for which I was prepared. The cases of 2′ 30·0″ were few; they do not appear in the diagram, but their addition would be quite insufficient to remove the difficulty, If the pinnacle were distributed among *two* adjacent columns outside and to the left of the diagram it would smooth away the incongruity, so I suspect that cases of "under 2′ 32″ and down to 2′ 30″" are habitually rated at a trifle less than 2′ 30″. Consequently I had no hesitation in wholly disregarding the entries that helped to make the pinnacle, namely, the whole of those contained in the first column to the left in every one of the diagrams. The course thereupon became clear and straightforward. I estimated the position of the mean value for each year, from inspection of the curve of that year, allowing myself to be somewhat biassed in estimating its point of culmination by the curves of the adjacent years; similarly as to the probable error. Now that the curves are drawn, I see that somewhat better fits might have been made, but they are close enough to show the existence of a fair amount of correspondence between the observed values and those calculated according to the law of normal frequency. It is near enough to remove hesitation in working with the arithmetic mean.

I now come to the fundamental purpose of this memoir, which is to point out the existence in the registers of the American Trotting Association, of a store of material most valuable to inquirers into the laws of heredity, which accumulates and increases in value year by year. But it seems to me hardly worth while to discuss hereditary influence on speed in horses, unless the records of at least their sires and of their dams, and those of each of their four grandparents, as well as their own record, are all known. Even in this case (according, at least, to my own theory) one quarter of the hereditary influences are unknown and have to be inferred. It is practically impossible to make an adequate collection of the names of horses who fulfil the above conditions out of the entries in the "Trotting Register," each search requiring many cross references and occupying a long time, while the number of futile searches before attaining a success is great. On the other hand, the breeders and possessors of these notably bred horses must be familiar with the required facts, and would assuredly be delighted to have them known. There need, therefore, be little difficulty in obtaining materials for the much desired table. In the meantime I am sending circulars to the chief breeders in America, in hopes of making a start.

The great need for genealogical data of an exact numerical kind, by those who prosecute inquiries into the laws of heredity, is the justification that I offer for submitting these remarks to the Royal Society.

Physical Society, January 21.—Mr. Shelford Bidwell, President, in the chair.—Prof. Fitzgerald exhibited some photographs by Mr. Preston in illustration of the Zeeman effect, for various cases, including those of iron, cadmium, zinc, and sodium. These photographs and the method of obtaining them have already been described. The cause of doubling is now attributed by Prof. Fitzgerald to absorption by the surrounding vapour. In a particular case he examined a double line that exists in one of the photographs. Under the polariser the two lines are at first distinctly seen; but when the polariser is turned, a thin line appears in the middle, and this central line is, therefore, circularly polarised in a direction opposite to that of the outer pair of lines. The reason for the appearance of doubling in the first position of the polariser is that the central line is there completely absorbed out by the surrounding vapour.—Prof. Oliver Lodge then gave a communication concerning his work on "Electric Signalling without Connecting-wires." From the nature of the oscillatory disturbances emanating from any of the customary forms of Hertz vibrator, syntony has hitherto been only very partially available as a means for discriminating between receivers. There is in fact so rapid a decrease in the amplitude of the vibrations that almost any receiver can respond to some extent. Discrimination by syntony is possible with magnetic systems of space telegraphy where the magnetic energy much exceeds the electric, *i.e.* as between two separated inductive coils; and by the use of such coils, appropriately applied, the author has been able to attain fair syntony even with true Hertz waves, *i.e.* he has constructed spark-gap oscillators, with sufficient persistence of vibration, and syntonised resonators. The "coherer" principle can be applied to either a purely magnetic or to the Hertzian system. It was first used by Prof. Lodge in devising lightning-guards, and afterwards in his magnetic system of telegraphy by inductive circuits, each in series with a Leyden-jar; a pair of knobs in near contact, or other over-flow gap, being provided in the receiving apparatus. This was the first meaning of a "coherer" in the electrical sense as used by Prof. Lodge. It referred to a *single* contact between two metal knobs. The term has since been extended by others to the filings-tube of M. Branly, and some confusion has arisen, for M. Branly does not consider that simple coherence and break explains fully the behaviour of his instrument. Prof. Lodge is disposed to agree, for he finds that the resistance of almost any form of coherer varies in rough proportion to the received impulses, and that there are other peculiarities (to be mentioned later). He is, therefore, inclined to think that the action cannot after all be entirely explained as due to mere "welding," but that there is something more to be learnt about it. The sensitiveness of a coherer depends upon the number of loose contacts; it is a maximum for a single contact, *i.e.* for a needle-point lightly touching a steel spring. With this sensitive coherer, hardly any "tapping-back" is required for decoherence, but it wants delicate treatment when properly adjusted, and the greatest current through it should not approach a milliampere. On the other hand, a Branly tube rather improves under rough treatment; in such a tube the author prefers to use iron filings in the best possible vacuum; brass, too, is very good, but rather less easy to manage. Aluminium is thoroughly bad, and gold, for an opposite reason, will not work—its surface is too clean. Points, or small surfaces for making contact with the filings, are better than large surfaces. The usual method of connecting the coherer across the gap of an ordinary Hertz receiver, in parallel with the telegraph instrument and battery, has the unavoidable objection that they shunt away part of the received oscillations. With the syntonic receiver of Prof. Lodge, which contains no gap, but a closed wire coil instead, this difficulty no longer exists; for the coherer can now be in series with the detecting instrument, and in so far as these obstruct the oscillations they may be shunted out in various ways, as the author describes. The main feature of his new syntonised vibrators is this self-inductance coil, whose function it is to prolong the duration of the oscillations, and thereby to render syntony possible. Although such a coil acts disadvantageously in so far as it possesses resistance, the resistance does not increase so fast as the self-induction. The coil should consist of thick copper of highest conductivity, and it should have maximum inductance for given resistance. For similar reasons, the capacity-areas should also be of highest conductivity, their dimensions should increase outwards from the spark-gap, as triangles. The receiver must have no gap, it should be accurately bridged over when a transmitter is used as receiver. The limit of speed of response depends upon the telegraphic instrument. Dr. Muirhead adapted a siphon-recorder to the purpose, because it is one of the quickest responders; he arranged it so that it could be used with intermittent currents direct. Under these intermittent impulses the siphon trembles; and instead of the ordinary siphon-signals, the slip is marked with dots and dashes. Constant mechanical tremor is usually employed for decoherence, but the author finds that decoherence can be brought about by electrical means, without any mechanical tremor, by connecting the coherer momentarily to a circuit less effective as a collector than that of the proper capacity-areas of the syntonised receiver. The battery and galvanometer detector-circuit may be used for this purpose, the coherer being momentarily connected to it, and while so connected letting it experience an impulse from a distance. Prof. Lodge has designed a revolving commutator by means of which the coherer can be rapidly changed over from the resonating circuit to the instru-

[1] I should like to take the opportunity afforded by the appearance of an abstract of my memoir in NATURE to correct a questionable suspicion, namely, that the pinnacles in the diagrams are due to tolerance shown towards horses who failed by a very little to qualify for the much-coveted rank of standard trotters. I am assured on excellent authority that the strict conditions of timing make this impossible (among other reasons there are three timers). On the other hand, there is a vast competition *just* to pass the 2′ 30″ limit; and when a horse has done so, his owner often does not care to train him for racing, but rather to utilise him at once for breeding or other purposes. The question is too complicated to discuss here at length. Suffice it that the 2′ 29″ to 2′ 30″ records are not homogeneous with the rest, and should be discarded as I proposed.—F. G.

ment-circuit, and finally to the "tapping-back" apparatus. A coherer is more sensitive when thus isolated and exposed to the full influence of the received oscillations; the subsequent detection of the effect by altered connections is very convenient for laboratory measurements. A diagram of a series of plotted measurements showed that the resistance of an undisturbed filings-tube is approximately a direct function of the intensity of the received stimulus, whether successive stimuli increased or decreased in strength. This electrical process of "tapping-back" is to be depended upon, but the process long continued fatigues the tube until a mechanical shake is employed to restore it. Large size apparatus made by Dr. Muirhead for actual distant syntonic work was exhibited, and means were shown for protecting and isolating the coherer when its receiving areas were being used as emitters; also a switch used for changing at one moment all the connections from "sending" to "receiving." Prof. Threlfall said he had come to the same conclusion as Prof. Lodge as to the advisability of diminishing the number of contact-points in the coherer. He had endeavoured to produce longer and more persistent waves, and thus to set afield greater effective energy. It was desirable to keep the waves as parallel as possible. He thought there was some probability that the wave-fronts could be altered and rendered more conformable by a process of diffraction. Mr. Rutherford also had found it best to work with long waves. He fully appreciated the advantage of increasing the capacity of the oscillator by extending the surface of the metallic plates. Mr. Campbell-Swinton asked whether experiments had been made to verify Hertz results as to the influence of reflectors behind oscillators and receivers. He had found them disadvantageous. A single wire behind either apparatus seemed partially to annul the effect. He also asked whether Prof. Lodge had observed the extraordinary sensitiveness of coherers to small changes of current in neighbouring circuits. Prof. Lodge, in reply, said he had observed the sensitiveness to slight sudden variations of current referred to by Mr. Campbell Swinton; for instance, when electric lamps were switched on or off. The effect of mirrors had been studied by Prof. Fitzgerald. They required to be of large dimensions as compared to the oscillator and receiver, otherwise the true reflections were not obtained. Dr. Silvanus Thompson afterwards exhibited a Tesla oscillator. This apparatus is intended to replace the two induction coils and spark-gap arrangements used by Mr. Tesla for high-frequency experiments. It consists of an induction coil with a separate self-inductance coil in the primary circuit. This self-inductance coil is also used as an electromagnet for the separate interrupter of the primary circuit. A condenser is connected between one end of the primary coil and one terminal of the interrupter, so as to include both of them between its terminals. The primary is a single turn of copper strip, six inches wide. The secondary is one layer of thick wire; each turn separated from the next by an air space. The supply current, about half an ampere, may be taken from the electric-light mains at almost any voltage from 50 to 200, direct or alternating. Prof. Lodge said it would work quite well at 10 volts. He pointed out also that if the straight discharge-rods at the spark-gap were free to slide, the discharge drove them back into their sockets. Prof. Fitzgerald said it was stated at Toronto that the spark was broken at the interrupter when the condenser was charged, and that by the time the condenser was ready to discharge, the contact at the interrupter had been made again. It seemed to him that the condenser discharges and surgings must take place at a rate far higher than the period of the mechanical movement of the interrupter. The condenser charges and discharges were very rapid. It was not what is ordinarily called the "time constant" that was involved, for that only referred to constant voltage. Here the voltage was changing very rapidly indeed. Prof. Herschel asked if such an apparatus was suitable for work with Röntgen rays. Dr. Thompson, in reply, congratulated Mr. Tesla upon the perfect working and compactness of his invention. The present form was not suited for Röntgen ray experiments, but Mr. Tesla had designed a special coil that was excellent for that purpose. —The President proposed votes of thanks, and the meeting was adjourned until February 11.

PARIS.

Academy of Sciences, January 24.—M. Wolf in the chair. —On the reduction of some double integrals, and on a new invariant in the theory of algebraic surfaces, by M. Émile Picard.—Addition to a preceding note on the Zeeman effect, by M. A Cornu. Some results of measurements showing that the magnitude of the separation produced increases with the refrangibility of the ray.—On the conditions of formation of alkaline carbides, and the carbides of magnesium and of the alkaline earths, by M. Henri Moissan. Metallic potassium, if left for a long time in acetylene, slowly but completely decomposes the gas giving hydrogen and C_2HK. Sodium gives a similar compound when sealed up with liquid acetylene, and this C_2HNa, heated in a vacuum, gives up pure acetylene, leaving sodium carbide C_2Na_2 behind; at a red heat this is decomposed into carbon and sodium. The potassium compound behaves similarly, neither sodium, potassium, nor magnesium carbides being able to exist at the temperature of the electric furnace.—Histological mechanism of cicatrisation; on true immediate reunion, by M. L. Ranvier. In wounds caused by cutting the cornea of the rabbit, two modes of closing up of the tissue can be noted, an immediate synaptic joining, and a true immediate joining, the former due to the cuts being filled with epithelial cells arising from the neighbouring epithelium, and the latter noticeable only in wounds forty-eight hours after the incision had been made, and where, owing to the lips of the cut happening to touch, no epithelial cells had penetrated.—The enlargement of the right auricle of the heart during inspiration demonstrated by radioscopy, by M. Ch. Bouchard.—On the fourth voyage of the *Princesse-Alice*, by S.A.S. Albert I., Prince of Monaco. The chief work was done on the western coast of Morocco, round Madeira and the Azores, and comprised sounding operations, together with zoological study of the fauna of the Princesse-Alice bank. A chart of this bank accompanies the paper.—Remarks by M. Edmond Perrier on his work on animal colonies and the formation of organisms.—Shooting-stars in the months of November and December 1897, observed at Basse-Terre (Guadeloupe), by M. Ch. Duprat.—On the development of uniform or holomorphic functions in any field, by M. Paul Painlevé.—On the types of increase and on complete functions, by M. Émile Borel.—On systems of partial differential equations analogous to equations of the first order, by M. Jules Beudon.—On the geometry of magnetic fields and of motion with two degrees of freedom in a plane or on a sphere, by M. René de Saussure.—Law of deformation of commercial metals, by M. Marcel Brillouin. A mathematical expression is given which includes all the known facts regarding permanent changes of shape in metals.—On an interference spectroscope, by MM. Ch. Fabry and A. Perot. The method consists in observing rings produced by transmission through a layer of air contained between two perfectly parallel silvered glass faces. Full details of the adjustments necessary are given in the present paper.—On the part played by diffraction in the effects produced with gratings, by M. Ch. Féry.—Study of chemical and physical equilibria by the osmotic method, by M. A. Ponsot.—On the law of mixture of gases, by M. Paul Sacerdote, giving the experimental results of mixing equal volumes of gases. The observed changes of pressure for a mixture of nitrous oxide and carbon dioxide, and of the latter gas with sulphur dioxide, are compared with those deduced from the densities by M. Leduc. The results of the two methods are in general agreement.—On the separation of thorium and the cerite earths, by MM. G. Wyrouboff and A. Verneuil.—The method proposed is based upon the fact that in a mixture of nitrates of the rare earths, as free as possible from excess of acid, heating with excess of hydrogen peroxide to 60° completely precipitates all the thoria in the solution.—Hydramides and the isomeric glyoxalidines, by M. Marcel Delépine. A thermochemical paper.—Researches on ouabaïne, by M. Arnaud.—Synthesis of terebic acid, by M. E. E. Blaise.—Manufacture of acetone oil, in particular of methyl-ethyl-ketone, by means of the liquors from the desuintage of wool, by MM. A. and P. Buisine. The calcium salts of the mixture of fatty acids obtained from wool is submitted to dry distillation. The resulting liquid yields on fractionation 60 per cent. of methyl-ethyl-ketone. —On the estimation of gastric juice, by M L. Cordier. The free acid is converted into lithium chloride by treatment with lithium carbonate, and this separated from the sodium chloride by extracting the incinerated residue with a mixture of equal parts of absolute alcohol and dry ether, in which the lithium chloride only is soluble.—Ergographical experiments for measuring the maximum power of a muscle regularly stretched, by MM. André Broca and Charles Richet.—The fungus *Sporotrichum globuliferum*, by M. Trabut.—On the anhydrous cal-

cium sulphate produced by the complete dehydration of gypsum, by M. A. Lacroix. The dehydration of gypsum gives rise to a calcium sulphate dimorphous with anhydrite, probably triclinic. When the drying was not quite carried to completion another form of crystal was observed, possibly $2CaSO_4.H_2O$.—On the Callovian of Woëvre, by M. René Nicklès.—On the third international ascent of experimental balloons, by M. Ed. Stelling. Two ascents were made, one with two observers, the other balloon carrying self-registering instruments only. The temperature variation with the height is given in full.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 3.

ROYAL SOCIETY, at 4.30.—Comparison of Oxygen with the Extra Lines in the Spectra of the Helium Stars β-Crucis, &c.; also Summary of the Spectra of Southern Stars to the 3½ Magnitude and their Distribution: F. McClean, F.R.S.—Researches in Vortex Motion. Part III. On Spiral or Gyrostatic Vortex Aggregates: Prof. W. M. Hicks, F.R.S.—The Pharmacology of Aconitine, &c., considered in relation to their Chemical Constitution: Prof. Cash, F.R.S., and Prof. Dunstan, F.R.S.—Note on the Experimental Junction of the Vagus with the Cells of the Superior Cervical Ganglion: Dr. J. N. Langley, F.R.S.

ROYAL INSTITUTION, at 3.—The Halogen Group of Elements: Prof. J. Dewar, F.R.S.

LINNEAN SOCIETY, at 8.—On the Muscular Attachment of the Animal to its Shell in some Fossil Cephalopoda (Ammonoidea): G. C. Crick.—The Comparative Anatomy of certain Genera of Cycadaceæ: W. C. Worsdell.

CHEMICAL SOCIETY at 8.—Effect of the Mono-, Di-, and Tri-chloracetyl Groups on the Rotatory Power of Methylic, and Ethylic Glycerates and Tartrates: Percy Frankland, F.R.S., and Dr. Thomas Stewart Patterson.—The Rotation of Ethylic and Methylic Di-monochloracetyltartrates: Percy Frankland, F.R.S., and Dr. Andrew Turnbull.—The Volumetric Estimation of Sodium: H. J. H. Fenton.

FRIDAY, FEBRUARY 4.

ROYAL INSTITUTION, at 9.—Some New Studies in Kathode and Röntgen Radiations: A. A. Campbell Swinton.

GEOLOGISTS' ASSOCIATION, at 7.30.—Annual General Meeting.—Palæolithic Man: E. T. Newton, F.R.S., President.

SATURDAY, FEBRUARY 5.

ROYAL INSTITUTION, at 3.—Cyprus: Prof. P. Geddes.

MONDAY, FEBRUARY 7.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Curing of Malt in relation to Colour and Value: J. W. Lovibond.—Clerget's Method of Estimating Cane Sugar: A. R. Ling.—A New Modification of Clerget's Method of Estimating Cane Sugar, specially applicable to Molasses and After Products: A. R. Ling and J. T. Baker.—Note on the Estimation of Water in Invert Sugars: Dr. L. T. Thorne and E. H. Jeffers.

TUESDAY, FEBRUARY 8.

ROYAL INSTITUTION, at 3.—The Simplest Living Things: Prof. E. Ray Lankester, F.R.S.

ROYAL HORTICULTURAL SOCIETY, at 3.—Annual General Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Security of Locomotive Fire-Boxes: William Thow.—Friction of Locomotive Slide-Valves: John A. F. Aspinall.

ROYAL VICTORIA HALL, at 8.30.—The Problem of the Great African Lakes: J. E. S. Moore.

WEDNESDAY, FEBRUARY 9.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Notes on the Electro-Chemical Treatment of Ores containing the Precious Metals: Major-General Webber, C.B.—An Electrolytic Process for the Manufacture of Parabolic Reflectors: Sherard Cowper-Coles.

SANITARY INSTITUTE, at 8.—Purification of Water for Barracks, Prisons, and other Institutions: Prof. J. Lane Notter.

THURSDAY, FEBRUARY 10.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Contributions to the Theory of Alternating Currents: W. G. Rhodes.—The Development and Morphology of the Vascular System in Mammals. I. The Posterior End of the Aorta and the Iliac Arteries: Prof. A. H. Young and Dr. A. Robinson.—Further Observations upon the Comparative Chemistry of the Suprarenal Capsules: B. Moore and Swale Vincent.

MATHEMATICAL SOCIETY, at 8.—The Transformations which leave the Length of Arcs on any Surface Unaltered: J. E. Campbell.—On Aurifeuillians: Lieut.-Colonel Cunningham, R.E.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Report of the Council.—Discussion upon Mr. Philip Dawson's Paper on Mechanical Features of Electric Traction.

FRIDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 9.—The Metals used by the Great Nations of Antiquity: Dr. J. H. Gladstone, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Annual General Meeting.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—Address by the President.—Also Paper: On Electromagnetic Induction in Plane, Cylindrical, and Spherical Current Sheets, and its Representation by Moving Trails of Images: Prof. G. H. Bryan, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Protection of Power Transmissions from Lightning: John T. Morris.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—First Report to the Gas-Engine Research Committee: Description of Apparatus and Methods, and Preliminary Results: Prof. Frederic W. Burstall.—Steam Laundry Machinery: Sidney Tebbutt.

MALACOLOGICAL SOCIETY, at 8.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

BOOKS.—Introduction to Chemical Methods of Clinical Diagnosis: Dr. H. Tappeiner, translated by Dr. E. J. McWeeney (Longmans).—Annuaire de l'Observatoire Royal de Belgique, 1898 (Bruxelles).—Lehrbuch der Gesammten Wissenschaftlichen Genealogie: Dr. O. Lorenz (Berlin, Hertz).—A Text-Book of Zoology: Profs. Parker and Haswell, 2 Vols. (Macmillan).—Mensuration, Hydrostatics, and Heat: G. H. Wyatt (Rivingtons).—Chemical Experiments: G. H. Wyatt (Rivingtons).—The Mathematical Theory of the Top: Prof. F. Klein (New York, Scribner).—Glass-Blowing and Working: T. Bolas (Dawbarn).—Report of the Commissioner of Education for the Year 1895–96, Vol. 2 (Washington).—Lose Blätter aus Indien, ii. (Batavia, Albrecht).—Arbeiten des Physikalischen-Chemischen Instituts der Universität Leipzig aus der Jahren 1887 bis 1896, Bd. 1 to 4, Herausgegeben von W. Ostwald (Leipzig, Engelmann).—Explosifs Nitrés: J. Daniel (Paris, Gauthier-Villars).—Observations and Researches made at the Hong Kong Observatory in the Year 1896: W. Doberck (Hong Kong).

PAMPHLET.—Old Age Pensions: W. Birkmyre (Glasgow, Aird).

SERIALS.—Geological Survey of Canada, Annual Report, Vol. 9: Pts. F. and S. (Ottawa).—Good Words, February (Isbister).—Sunday Magazine, February (Isbister).—Botanische Jahrbücher, &c. Vierundzwanzigster Bd., 3 Heft (Berlin, Engelmann).—National Review, February (Arnold).—Century Magazine, February (Macmillan).—Record of Technical and Secondary Education, January (Macmillan).—Contemporary Review, February (Isbister).—Bulletin de l'Academie Royale des Sciences, &c., de Belgique, 1897, No. 12 (Bruxelles).—Terrestrial Magnetism, December (Cincinnati).

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THURSDAY, FEBRUARY 10, 1898.

THE BOOK OF THE DEAD.

The Book of the Dead. The Chapters of Coming Forth by Day. The Egyptian Text according to the Theban recension in hieroglyphic edited from numerous papyri, with a translation, vocabulary, &c. By E. A. Wallis Budge, Litt.D., D.Litt., F.S.A., Keeper of the Egyptian and Assyrian Antiquities in the British Museum. In three volumes. Pp. cciv + 354; xl + 517; vii + 386. (London: Kegan Paul, 1898.)

IN the first of the Gifford Lectures for 1896, Prof. Tiele gave an admirable sketch of the method of work which the student of the modern science of religion must pursue if he is to achieve any lasting results. The process is a long one, for he must acquaint himself with the whole field of religion and be master of the material with which he works; and he should, in the Professor's opinion, have taken part himself in exploring and clearing the ground, and have studied at least two religions in the original sources. We fear that for many workers in this comparatively recent field of study the lecturer's words came as a counsel of perfection. But even working by Prof. Tiele's high standard, the range of study is so broad that the student of religion can obtain only a small proportion of his information at first hand, and for the greater part of his material must make use of the labours of others; in the wider field of anthropology, which in one sense includes the science of religion—though Prof. Tiele would not here agree with us—the range of study is still more extensive. For information respecting the culture, customs and beliefs of savage and undeveloped races of the present day, the student must consult the works of travellers, missionaries, and trained collectors and explorers; while for the beliefs of the ancient nations of the world, he necessarily to a great extent depends on the translations made by scholars who have devoted their energies to the interpretation of the sacred books and documents that have come down to us. Prof. Max Müller's "Sacred Books of the East," for example, supply him with ample material in his examination of the beliefs of the ancient Aryan races; though it must be admitted the religious works of many other ancient nations still need trustworthy translations. The want of such a translation of the great religious work of the ancient Egyptians has long been felt, but it is now met by Dr. Wallis Budge's translation of the "Book of the Dead."

The importance of the "Book of the Dead" in its bearings on the religion of the ancient Egyptians cannot be over-estimated. Including as it does their whole system of belief, it is our principal source of information on the subject. It is true that collections of moral precepts, hymns and prayers to the gods, mythological texts and legends, all contribute something to our knowledge; but the collection of compositions, to which the title "Book of the Dead" has been applied, is in itself the embodiment of the Egyptian's creed, and from it alone can any true understanding of his religion be obtained. For many years the work was known only in publications of single papyri of different periods, the most important of which was that published in 1842 by Lepsius, whose numbering of the chapters has been retained by all subsequent editors. It was not until more than thirty years later that any complete edition of the work was contemplated. In 1874, at a meeting of the International Congress of Orientalists, a scheme for such an edition was projected, and M. Naville undertook the work. Confining himself to papyri of the eighteenth to the twentieth dynasties, during which period the finest papyri of the "Book of the Dead" were written, he in 1886 produced a critical edition of the Theban recension of the work, which he published with an introduction but no translation. In the new edition of the work just issued, Dr. Budge has added considerably to M. Naville's text by using some unique papyri—which have been acquired during recent years by the British Museum. In another volume he has published a complete vocabulary to the text, which will prove of great service to Egyptologists. But the volume which marks the greatest advance on previous editions, and with which we are here concerned, is the one in which Dr. Budge gives a complete translation of the text, a work that has long been needed, but which he is the first to have accomplished; the translation is preceded by an introduction, in which he deals with the origin, aim and contents of the "Book of the Dead," and states the conclusions at which he has arrived as the result of many years of study.

The many points suggested by such a work cannot be adequately treated within the limits of a review, and it will be necessary to confine our attention to certain parts of the introduction where Dr. Budge has developed his theories with regard to the "Book of the Dead." One of the most important chapters of the introduction is that devoted to the history of the "Book of the Dead." The four main recensions of the work have long been recognised by scholars, that of the Old and Middle Empires, the Theban version, the version of the twentieth dynasty, and the text of the Saite and Ptolemaic periods. Dr. Budge, however, strikes out a novel line in his sketch in the history of the work, by going back beyond the time of the pyramid-builders of the fifth and sixth dynasties, and seeking in the remains of prehistoric Egypt the causes that led to the subsequent development of the work. In the graves recently excavated at El-'Amrah near Abydos, which possibly belonged not to the Egyptians themselves, but to their predecessors in the land, were found skeletons showing traces indicating that the bodies to which they belonged had been embalmed. This custom of preserving the bodies of their dead, which we thus find in existence at the dawn of Egyptian civilisation, lasted without a break through the whole period of the nation's history down to the fourth century A.D. In what way it gave rise to the "Book of the Dead" is best described in Dr. Budge's own words:—

"As time went on the embalming of the dead was performed in a more elaborate manner, and at the same time the last resting place of the mummified body was chosen more carefully and wrought with greater attention. At a very early period the wealthy discarded the use of holes in rocks and caves as tombs, for in these the bodies were accessible to the attacks of enemies, and wild animals and serpents; and the same objection was,

naturally, made to shallow hollows made in the limestone and covered over with slabs of the same material, and also to the vaulted, crude brick graves which were commonly in use in the early dynasties. The place of these was taken by pyramids built of stone, and by many-chambered tombs hewn in the living rock. Experience, however, soon showed the Egyptian that the most carefully constructed tomb was incapable of preventing damp-rot or dry-rot and decay, and that some other power besides his own must be invoked to prevent the destruction of his body, which, though needing longer time to accomplish, was as effectually performed by these means as by the tooth of the wild animal or serpent, or by the hand of the enemy. At this stage the aid of the professional religious man or priest was called in, and the task of finding means to prevent rot and decay was entrusted to him. There is little doubt that when the body was laid to rest in the tomb, the priest pronounced certain words or formulæ or prayers over it, and it is probable that the recital of these words was accompanied by the performance of certain ceremonies. Whatever these formulæ were they formed the foundation of the 'Book of the Dead' of later Egyptian times."

This is a reasonable theory as to the origin of the work, and we think Dr. Budge is also justified in the further assumption that though these formulæ were first only recited, they were afterwards written down by the priests with a view to preserving them, and that the custom of inscribing portions of them on the walls of the tomb, and of writing them on the coffin and on papyri deposited in the tomb, followed from the subsequent belief that their efficacy was thus insured for the benefit of the deceased. In a series of eighteen plates Dr. Budge has illustrated the changes of form which the "Book of the Dead" underwent in the long course of its development from the time when we find it on the walls of the pyramids at Ṣaḳḳāra, to its final deterioration in compositions of the Roman period. Its culmination in the illuminated papyri of the eighteenth dynasty is illustrated by means of three very beautiful coloured plates representing portions of the famous papyrus of Ani in the British Museum.

Another section of the introduction, which will prove useful to any one who attempts to understand the "Book of the Dead," is that which Dr. Budge devotes to its object and contents. He here classifies the chapters according to their subject-matter, and we thus gain an insight into the underlying unity of the work; for, though its chapters represent beliefs belonging to all ages in the life of the nation, the aim underlying them all is in some way or other to benefit the deceased. "They were intended," says Dr. Budge, "to give him the power to have and to enjoy life everlasting, to give him everything which he required in the life beyond the grave, to ensure his victory over his foes, to procure for him the power of going whithersoever he pleased and when and how he pleased, to preserve the mummy intact, and finally to enable his soul to enter into the bark of Rā or into whatever abode of the blessed had been conceived of by him." We have not space to enter into any adequate discussion of the exact nature of the ancient Egyptian's belief in a resurrection and a judgment, or to consider how far he advanced in his conception of monotheism. He never outgrew his belief in magic, and while undoubtedly advancing in his notions of a spiritual existence, he did not discard the more primitive tenets of an earlier age. It is constantly necessary to bear this fact in mind in reading the "Book of the Dead." By his translation of the work, Dr. Budge has earned the gratitude of all students of the science of religion, for he has thereby placed within their reach a wealth of fresh material. For the benefit of those who are not Egyptologists, we are glad to note that the introduction and translation are issued as an independent work, and sold separately from the volumes containing the hieroglyphic text and vocabulary.

FERNS.

Die Farnkräuter der Erde. By Dr. H. Christ. Pp. viii + 388; with 291 figures. (Jena: Gustav Fischer, 1897.)

SINCE the publication of Baker's "Synopsis Filicum" in 1873 (Dr. Christ makes no mention of John Smith's "History of Ferns," 1877) no complete systematic account of the ferns has appeared, so that there is room for a work which embodies the more modern discoveries in this subdivision of plants. During this interval, Dr. Christ says a number of new species have become known, and, owing to the researches of G. Mettenius into the general structure of this subdivision, additional materials are to hand for the elaboration of a more natural arrangement. He believes that the older authors, including Hooker, too rigidly limited themselves to the consideration of the sorus and indusium for purposes of classification. Influenced by these reflections he has been led to change the arrangement adopted in the "Synopsis Filicum," in several cases, for what he regards as a more natural grouping. His view of the matter is, however, sometimes open to doubt. The position he assigns to the genus Loxsoma may be taken as an example of one of such alterations. He transfers it from the Hymenophyllaceæ to the Polypodiaceæ, apparently because its leaves have several layers of cells and are furnished with stomata. On the other hand, its sorus and indusium resemble those found in the Hymenophyllaceæ. An alteration like this may be defended or assailed according to the personal feeling of each systematist, and its criticism will depend on what morphological value each individual places on the various diagnostic characteristics. But it appears that the structure of the leaves, taken alone, would often be misleading. The leaves of a few of the Hymenophyllaceæ are several layers thick; while in the Osmundaceæ—a group, for the most part, possessed of stout leaves—Leptopteris has delicate and filmy leaves without stomata. The existence of the fossil *Palæopteris hibernica*, which had leaves resembling Loxsoma, but in other respects belonging to the Hymenophyllaceæ, renders the connection of the latter genus to that class of ferns more probable.

Again, Dr. Christ removes *Ceratopteris thalictroides* (a plant which, by the way, is omitted in the index, but described in the text) from the Polypodiaceæ into a separate class, the Parkeriaceæ, without, it might be thought, sufficient reason. The anomalies in the structure of its vegetative organs may well be accounted for by its watery habitat, unique among the filices.

The two species of Matonia are placed in a separate group, as Baker suggested.

It is disappointing to find that no mention is made of the gametophyte in ascertaining the relations of the classes to one another; although its systematic value has been shown in several cases. It is quite possible that the position of doubtful genera, such as Loxsoma, will only be understood when its gametophyte has received complete investigation. The omission, however, may be justified owing to the practical difficulties of obtaining the sexual generation for systematic purposes.

The introduction is short and is chiefly occupied with explaining the scope of the book; and it seems a pity that a writer, with so much knowledge of the ferns, did not give more space in his work to general considerations. At the end, however, Dr. Christ refers to the marked manner in which ferns belonging to different classes resemble one another: thus, Diacalpe—a member of the Aspidiaceæ—has a sorus very like that found in the Cyatheaceæ. In the Polypodiaceæ some genera have the sorus situated at the tip of the veins and projecting beyond the margin of the leaves, in this reminding us of the Hymenophyllaceæ. It is fanciful, if not inaccurate, to see in this position of the sorus a resemblance to the mosses. Other interesting examples are given; but it is unfortunate that the author applies the term "mimicry" to these instances of parallelism in related groups. Such an application of the term must only lead to confusion.

The descriptions of the genera and species are marked by their precision and lucidity, and the numerous illustrations, which were specially prepared for this work, are characteristic drawings, though sometimes roughly executed. The appearance of such a book will be welcomed by systematists interested in the ferns containing, as it does, the more recent results of Baker, Hooker, Kuhn, Luersson, Prantl, &c., and those of Dr. Christ himself.

It might be suggested that if the key of genera, which precedes the detailed diagnoses of genera and species, was furnished with references to the pages on which the diagnoses are to be found, an addition would be made to the usefulness of the book. H. H. D.

SCIENCE IN FICTION.

The War of the Worlds. By H. G. Wells. Pp. 303. (London: William Heinemann, 1898.)

MANY writers of fiction have gathered material from the fairy-land of science, and have used it in the construction of literary fabrics, but none have done it more successfully than Mr. H. G. Wells. It is often easy to understand the cause of failure. The material may be used in such a way that there appears no connection between it and the background upon which it is seen; it may be so prominent that the threads with which it ought to harmonise are thrown into obscurity; or (and this is the worst of all) it may be employed by a writer whose knowledge of natural phenomena is not sufficient to justify his working with scientific colour. Mr. Wells makes none of these mistakes. Upon a groundwork of scientific fact, his vivid imagination and exceptional powers of description enable him to erect a structure which intellectual readers can find pleasure in contemplating.

"The Time Machine"—considered by the majority of scientific readers to be Mr. Wells' best work—showed at once that a writer had arisen who was not only familiar with scientific facts, but who knew them intimately enough to present a view of the future. "The Island of Dr. Moreau," though decried by some critics, is a distinctly powerful work, and the worst that can be said of it is that the pabulum it provides is too strong for the mental digestion of sentimental readers. But in several respects "The War of the Worlds" is even better than either of these contributions to scientific romance, and there are parts of it which are more stimulating to thought than anything that the author has yet written.

The invasion of the earth by inhabitants of Mars is the idea around which the present story is constructed The planet is, as Mr. Percival Lowell puts it, older in age if not in years than the earth; and it is not unreasonable to suppose that if sentient beings exist upon it they would regard our world as a desirable place for occupation after their own globe had gone so far in the secular cooling as to be unable to support life. Mr. Wells brings the Martians to the earth in ten cylinders discharged from the planet and precipitated in Surrey. The immigrants are as much unlike men as it is possible to imagine, and only a writer familiar with the lines of biological development could conceive them. The greater part of their structure was brain, which sent enormous nerves to a pair of large eyes, an auditory organ, and sixteen long tactile tentacles arranged about the mouth; they had none of our complex apparatus of digestion, nor did they require it, for instead of eating they injected into their veins the fresh living blood of other creatures. Their organisms did not sleep any more than the heart of man sleeps; they multiplied by budding; and no bacteria entered into the scheme of their life. When they came to the earth they brought with them a means of producing a ray of intense heat which was used in connection with a heavy vapour to exterminate the inhabitants of London and the neighbourhood.

This bald outline does not, however, convey a good idea of the narrative, which must be read before the ingenuity which the author displays in manipulating scientific material can be appreciated. The manner in which the Martians are disposed of is undoubtedly the best instance of this skill. As the Martians had eliminated micro-organisms from their planet, when they came to the earth their bodies were besieged by our microscopic allies, and they were destroyed by germs to which natural selection has rendered us immune. This is a distinctly clever idea, and it is introduced in a way which will allay the fears of those who may be led by the verisimilitude of the narrative to expect an invasion from Mars. Of course, outside fiction such an event is hardly worth consideration; but that the possibility of it can be convincingly stated, will be conceded after reading Mr. Wells' story. A remarkable case of the fulfilment of fiction is furnished by the history of the satellites of Mars. When Dean Swift wrote "Gulliver's Travels" (published in 1726), he made the astronomers on the island of Laputa not only observe two satellites, but caused one of these to move round the planet in less time than the planet itself takes to rotate on its axis.

As every student of astronomy now knows, the satellites were not discovered until 1877, and one of them actually does revolve round Mars three times while the planet makes a rotation. The coincidence is remarkable; but it is to be hoped, for the sake of the peace of mind of terrestrial inhabitants, that Mr. Wells does not possess the prophetic insight vouchsafed to Swift.

In conclusion, it is worth remark that scientific romances are not without a value in furthering scientific interests; they attract attention to work that is being done in the realm of natural knowledge, and so create sympathy with the aims and observations of men of science. R. A. G.

OUR BOOK SHELF.

Introductory Course in Differential Equations. By D. A. Murray, B.A., Ph.D. Crown 8vo. Pp. xv + 234. (New York and London: Longmans, Green, and Co., 1897.)

Ordinary Differential Equations; with an Introduction to Lie's Theory of the Group of One Parameter. By James Morris Page. Crown 8vo. Pp. 226 + xviii. (London: Macmillan and Co., 1897.)

MR MURRAY'S book is adapted to provide for students that knowledge of the subject of differential equations which they are likely to want in applications of mathematics to physics, and in the general courses in arts and science in "classical" colleges. The author is chiefly occupied with giving expositions of the devices usually employed in the solution of the simple differential equations which such students meet with, and he will be found a safe guide in these matters. He follows the plan, which most recommends itself to teachers, of omitting theoretical considerations, or postponing them until the student has had practice in carrying out the processes with which he must be acquainted before the theory can be understood. But he does not leave the reader altogether in the dark as to the underlying theory and the modern developments. These are considered near the end of the book in a series of notes, which ought to prove very useful to those who wish to know more about the subject than can be learned from the text. In one case, that of the integration of linear equations in series, the author has departed from his general practice of giving an account of the simple and particular rather than of the difficult and general. It seems unfortunate that he did not choose for discussion the forms of the series which satisfy such equations in the neighbourhood of ordinary points. When a second edition is called for he will do well to alter this, and to avoid such expressions as "concentric cylinders" and "consecutive curves." The book is well printed, and is adequately supplied with well-chosen examples, some of them relating to physical subjects; and it ought to prove of service both to those for whom it is primarily intended, and also to British students who have not time to master Forsyth's treatise, but wish to learn rather more about the subject than is to be found in Lamb's "Infinitesimal Calculus."

In several important respects Mr. Page's book differs considerably from most existing text-books on differential equations. It is not sufficiently elementary for students reading the subject for the first time, since it makes no attempt to supply that thorough drilling in the solution of linear equations with constant coefficients and other simple forms, which our Universities insist on as a preliminary test of proficiency. Those, however, who have passed beyond the threshold of the subject, and who wish to study the general machinery underlying the methods they have learnt, will find in Mr. Page's work the first attempt to present to English readers a concise account of some of Prof. Lie's important developments of the theory of transformation groups, by which he has shown that the usual methods are only applicable to such differential equations as admit of known infinitesimal transformations. A great many of the methods here described are due exclusively to Prof. Lie; the examples at the end of each chapter are, however, largely taken from existing text-books. A feature which strikes us as distinctly good, is the treatment together of simultaneous systems and the equivalent linear partial equation.

The two books before us are thus, to a great extent, complementary in scope. Starting with no knowledge of differential equations, a course of study first under Mr. Murray's and then under Mr. Page's guidance will lead the student by easy stages up to an insight into the Theory of Groups.

Nature Study in Elementary Schools; a Manual for Teachers. By Mrs. L. L. W. Wilson. Pp. xix + 262. Woodcuts. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897.)

THERE is a notion in this book—a sensible, practicable notion; and this is enough to distinguish Mrs. Wilson's lessons from the common run of school natural histories. Her aim is to stimulate the children to work for themselves; and now and then she succeeds in laying out really interesting work for them, as in the lessons on seedlings and on some common American trees. We recommend the book to the notice of enterprising teachers. In spite of very obvious defects, it may be a guide to better methods than those which prevail at this time. The great fault of the book is the feeble execution of an excellent idea. Many of the lessons do no sort of justice to the objects, and pass over without remark features which ought to arouse the curiosity of the children. We can hardly understand how any teacher could work through the thorn-apple with a class, and then write down so poor a description as that on p. 19. Many of the drawings, particularly those of insects, are too crude and hasty to be produced as examples even of what can be done in school. In the present writer's opinion the mythology and the poetical pieces are overdone. These things may be allowed to come in as extempore illustrations; but when they are laboured, they simply distract the attention and prevent the children from focussing their minds upon the objects.

A word as to the use of printed lessons. On no account should the book be produced in class; that would be to give the solution of the problems in advance. Nor should the teacher reproduce the very lessons given in the book, but devise lessons of his own upon the same lines. In this way the book now before us can be turned to excellent account. L. C. M.

Botanical Microtechnique: a Handbook of Methods of Preparation, Staining, and of Microscopical Investigation of Vegetable Structures. By Dr. A. Zimmermann, Privat-docent in the University at Tübingen. Translated from the German by James Ellis Humphrey, S.D. Pp. xii + 296. (Westminster: Archibald Constable and Co., 1896.)

MODERN advanced work in vegetable, as in animal, histology requires the aid of a refined and often complicated technique in order to render apparent the more difficult details of structure. The zoologist possesses at least one good treatise on methods; but until the appearance, in its English form, at the hands of Dr. Humphrey, of Zimmermann's excellent work, there was no advanced handbook available to a student unacquainted with German. The scope of the book is sufficiently indicated by the title, and under its new form can be confidently recommended to English-speaking students.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Bipedal Lizards.

I COMMUNICATED to NATURE, July 22, 1897, the intelligence that I had demonstrated by practical experiments that both the Australian Water Lizard (*Physignathus Leseuri*) and the Muricated Tree Lizard (*Amphibolurus muricatus*) shared with the Australian Frilled Lizard (*Chlamydosaurus kingi*) the singular faculty of running erect on its hind legs only. In that letter I refer to the as yet unconfirmed rumour that the Mexican Iguanoid Lizard (*Corythophanes Hernandeseyi*) also runs bipedally, and express the opinion that, judging from the close correspondence in general structure—more especially as regards the abnormal length of the hinder limbs—that exists between many of the American Iguanidæ and the Australian Agamidæ, it will probably be found that a corresponding bipedal mode of locomotion is shared by many allied members of the first-named family.

As a result of that communication and of a further ventilation of the subject in a paper recently read by me at the Royal Colonial Institute,[1] I have quite recently received an extensive and exceedingly interesting confirmation of my anticipations. Mr. Henry Prestoe, a twenty years' resident in the West Indies, writes me as follows:—"I have been struck by your remarks on the bipedal locomotion of the Frilled Lizard. It has occurred to me you would be glad to learn, if only in confirmation of your views, that with all the lizards—from the large Iguana,

FIG. 1.—Leseur's Water Lizard (*Physignathus Leseuri*), running erect.

which lives in trees chiefly and is about five feet long when full-grown, down to the smallest mite one sees occasionally about the stones, I have ever seen running, the method of hurried locomotion is *bipedal*. The most familiar example is the so-called Diamond Lizard, common in the pastures and pleasure-grounds of Trinidad, 18 to 24 inches long, including the tail. The attitude results, when the progress is over a muddy surface, in footprints exactly like those of a small fowl, going lightly, and accounted in my mind years ago for the occurrence of bird-like footprints much further down in geological strata than birds are known to have existed. The motion of the legs of the Diamond Lizard, when running, is so rapid as to render them for the time invisible. But in the case of the large Iguana the case is different, and it takes an effort to get up into the slanting position which the Diamond and smaller lizards assume at once. Meantime the action or "swing" of the behind feet is that of an ordinary duck—accentuated—remaining grotesque in fact so long as the more or less erect position is kept up."

Mr. Prestoe has informed me of the further interesting fact that there are many figures traced on the rocks about the watershed of the Guianas, certain of which unmistakably represent a lizard, such as the Diamond species, running on two legs. A figure Mr. Prestoe has supplied me with as a fair reproduction of one of the rock scratchings corresponds in a noteworthy manner with the silhouette-like representation of Leseur's Water-lizard obtained by myself when taking an instantaneous photograph of the animal in its most characteristic bipedal attitude.

[1] "Australian Natural History Gleanings." (*Journal of the Royal Colonial Institute*, January 1898.)

This phenomenon of bipedal locomotion, now shown to be common to many lizards that differ not only in their modes of life and widely separated habitats, but also in essential structural features, can scarcely fail to commend itself to the closer attention of the systematic biologist. When, as first reported by me, only a single species, *Chlamydosaurus kingi*, could be accredited with this remarkable mode of locomotion, it was interpreted as

FIG. 2.—Australian Muricated Tree Lizard (*Amphibolurus muricatus*), running erect.

most probably representing a habit that had been independently and recently acquired. Now, however, the demonstrated fact of its widespread occurrence is clearly indicative of its inheritance from a remoter ancestry with whom bipedal locomotion also constituted a common method of progression. The question is, who were they?

Apart from the foregoing considerations, I would suggest that the provision of conditions at our Zoological Gardens under which the many lizards possessing bipedal habits could exercise their singular but hitherto almost completely overlooked athletic accomplishments, would prove a great attraction to both naturalists and to the general public. Several varieties of these bipedal lizards are now on view in the Reptile House. They are at present, however, confined in relatively small cages, and, as I have demonstrated by practical experiments, it is essential for their display of bipedal locomotion that a level floor, with a free run of at least 20 or 30 feet, should be at their disposal.

Instantaneous photographs taken by me—but hitherto unpublished—illustrating characteristic attitudes assumed by *Physignathus Leseuri* and *Amphibolurus muricatus*, when running erect, are herewith reproduced.

W. SAVILLE-KENT.

The Glacial Period and the Irish Fauna.

MR. LAMPLUGH assumes (NATURE, January 13, p. 245) the correctness of the view that during the Glacial Period the basin of the Irish Sea was filled with an ice-sheet, and argues that my "interesting speculations" on the origin of the Irish fauna, in so far as they are based upon assumptions as to the glacial conditions of the Irish Sea, will therefore possibly not meet with much acceptance among geologists. That the Irish Sea, however, was filled with an ice-sheet during the Glacial Period is certainly not universally accepted among geologists. I think also, that it would have been more advantageous to us to hear Mr. Lamplugh's remarks, after having read in full my paper dealing with the origin of the Irish fauna, instead of the short abstract in NATURE. He would then have observed that I particularly avoided basing assumptions as to the origin of the Irish fauna on the glacial conditions of the Irish Sea. It has been rather too much the practice among some geologists of late, not only to assume the correctness of their theories as to the nature of the Glacial Period, but also to base thereon the probable course of events of the migrations of animals and plants. I have attempted, with a view to arriving at a more satisfactory conclusion on the origin of the British fauna, to found my deductions almost entirely on the presence in or absence from the British Islands of continental species. These conclusions are at variance with the views held by the, what we might call, extreme Glacial school of geologists.

In dealing with this subject, it seems to me, there is nothing gained in reiterating the same assumptions over and over again; and it really is immaterial whether the reindeer, the Irish elk, and dozens of other animals can or cannot cross ice. This does

not affect the British fauna as a whole very much. The bulk of the English and Irish animals *must* have travelled to these islands on a land-surface which was not covered by ice, and how they did so and when, is the problem at issue. To attack this problem from a purely zoological point of view will, I think, be of great service to geological science, and will help to clear up many doubtful points as to the nature and cause of the Glacial Period. R. F. SCHARFF.

Science and Art Museum, Dublin, January 31.

I CAN assure Dr. Scharff that I took pains to read his full memoir before venturing to discuss it, as I think he should have recognised from the fact that the passage which I quoted from it did not occur in the abstract printed in NATURE.

I readily acknowledge my inability to discuss the purely zoological questions which he has raised, and purposely avoided any attempt to do so. But as his methods have led him to conclusions as to the past geological conditions of the Irish Sea basin which are demonstrably at variance with the geological field-evidence in a crucial area, it seems desirable that a geological protest should be recorded against them.

If Dr. Scharff could be persuaded to reconsider his subject from a standpoint which should include both the zoological and the geological evidence, he might yet find some solution which would be satisfactory to the students of both sciences.

G. W. LAMPLUGH.

On Augury from Combat of Shell-fish.

IN a foot-note to my letter on this subject (NATURE, vol. lvi. p. 30, May 13, 1897), I remarked that the *Khchau* (a shell-fish), applied by the Cambodians to the divination of a war, is likely to belong to the family of Paludinidæ, taking into consideration the fact that the Japanese and the Chinese of former days used some species of viviparus (= Paludina) for the same purpose. Lately, while examining M. A. Parvie's article "Excursions dans le Cambodge, &c." in *Cochin-Chiné Française; Excursions et Reconnaissances*, No. 9, p. 479, 1882, I have come across a passage giving confirmation to my view, The author, giving nomenclatures of the Cambodian molluscs, identifies the native *Kechau* (which is doubtless another French form of the spelling *Khchau*) with the Latin "Paludina"; whereas the allied genus Ampullaria has its Cambodian name "Tal." KUMAGUSU MINAKATA.

January 31.

THE TOTAL ECLIPSE OF THE SUN.

VIZIADURG, *Monday, January* 17.

THE work is so incessant here from sunrise to midnight that I have not time to give anything like an adequate idea of our doings. I may say, however, that we have been here since last Saturday week, and everything is ready for the eclipse. We have now over 120 volunteers. Captain Chisholm-Batten has taken charge of the whole arrangement, and to me, an old eclipser, it is a beautiful thing to see the splendid drill which we have commenced in eclipse form, along all lines, to-day, going on to the sound of the bugle. The observers have been arranged into twenty-one parties as follows:—

Observing Parties.

	Instruments, &c.	Staff.
I.	6-inch prismatic camera	7
II.	9-inch prismatic camera	8
III.	Integrating spectroscope	3
IV.	Discs	18
V.	Sketches of corona, without discs ...	12
VI.	Colours of landscape	6
VII.	Shadow phenomena	8
VIII.	6-inch equatorial, with grating spectroscope	5
IX.	3¾-inch equatorial	3
X.	Hand spectroscopes, with slits	6
XI.	Prisms for observations of ring spectra ...	7
XII.	Timekeepers	3
XIII.	Contact observations	2
XIV.	Polariscope	2
XV.	Observations of temperature	13
XVI.	Observations of stars during totality ...	7
XVII.	Landscape cameras for shadow, &c. ...	7
XVIII.	Observations of shadow bands	3
XIX.	Kinematograph for eclipse	4
XX.	Kinematograph for shadow	2
XXI.	Coronograph	3
	Total	129

FIG. 1.—Camp, Saturday, January 8. Putting in concrete pillars.

Incessant instruction has been going on since the eclipse party joined the *Melpomene* at Colombo; but in this I have had quite a subordinate part to play, for the officers are past masters in many of the subjects which concern

us. Our log of lectures, &c., between January 5 and 17, runs something like this :—

LECTURES, &C., JANUARY 5–17, 1898.

Wednesday, January 5.

General lecture.
Corona drawing.

Thursday, January 6.

Corona drawing, conducted by Mr. Fowler.

Saturday, January 8.

Lecture on spectra (forenoon).
Lecture on spectra (afternoon).
Colours of landscape, by Lieut. Dugmore, R.N.
Corona drawing.

Monday, January 10.

Lecture on spectra, by Lieut. Colbeck, R.N.

Tuesday, January 11.

Lecture on spectra, by Engineer Mountifield, R.N.
Colours of landscape, by Lieut. Dugmore, R.N.
Corona drawing, by Lieut. Dugmore, R.N.

Wednesday, January 12.

Sketches of corona, with discs.

Thursday, January 13.

Colours of landscape, by Lieut. Dugmore, R.N.
Sketches of corona, with discs.

Rehearsal of drills for—

6″ prismatic camera—9″ prismatic camera—Description and sketches of corona, with discs—Timekeepers.

Friday, January 14.

Lecture on observations of stars during totality, by Lieut. Blackett, R.N.

Rehearsal of drills for—

6″ prismatic camera—9″ prismatic camera—Integrating telescope—Descriptions and sketches of corona, with discs—6″ equatorial—3¾″ equatorial—Timekeepers—Coronograph—Colours of landscape.

Saturday, January 15.

Drill for—

6″ equatorial (morning), conducted by Prof. Pedler.

Rehearsal of drills for—

6″ prismatic camera—9″ prismatic camera—Integrating telescope—Descriptions and sketches of corona, with discs—6″ equatorial—3¾″ equatorial—Timekeepers—Coronograph—Colours of landscape.

Monday, January 17.

Drill for—

6″ equatorial, conducted by Prof. Pedler.
Instruction on landscape cameras, by Messrs. Fowler and Turner.

Rehearsal at eclipse time of drills for—

6″ prismatic camera—9″ prismatic camera—Integrating telescope—6″ equatorial—Timekeepers—Coronograph.

Rehearsal at 5 p.m. of—

6″ prismatic camera—Integrating telescope—Timekeepers—Description and sketches of corona, with discs—3¾″ equatorial—Coronograph—Colours of landscape—Kinematograph for shadow.

The climate here is delightful, and the weather has been up to the expected standard. To-day we have had a good deal of cloud after eclipse time; but our hopes are very high in spite of this, for it all disappeared before sundown, and to-night the zodiacal light has testified to the clearness of the air. From the first the arrangements of the Public Works Department have been admirable, and all the work has gone on like clockwork, till at last a large space in the Forts is now covered with structures of matting shielding the instruments, which leave nothing to be desired. Great precautions have also been taken against exposure to the sun, and as a result we are all perfectly well. It is impossible to say enough as to the help which the Captain of the *Melpomene* has given to the whole enterprise; he has anticipated all requirements down to the minutest detail. As at Kiö a signal station has been established, and everything the ship can lend, down to fire-buckets, is at our disposal in twenty minutes. The Collector of Ratnagiri, Mr. Bomanji, is also encamped here. At present he is our host, and any local assistance necessary is at once rendered; at first we had great difficulties, as the Bombay authorities imagined everything could be worked from the ship.

FIG. 2.—Camp, Monday, January 17. All instruments adjusted and drills commenced.

We have no news of the other parties, but Mr. Eliot, C.S.I., F.R.S., is expected to-morrow to take charge of the meteorological observations, and he doubtless will bring observers with him.

I enclose some photographs of the various instruments with their shelters. During the eclipse everything sunward will come down, and arrangements have been made so that everybody will have 40 seconds for a square look at the eclipse. The eclipse clock and timekeepers (we have a relay, one relieving the other at "65 seconds more") are working splendidly.

The new dropping-shutters, 16 × 6½, promise excellently; ten photographs of the spectrum can be taken in 10 seconds. A boat will be moored at the spot which we calculate the shadow will reach 5 seconds

FIG. 3.—9-inch Prismatic Camera, showing arrangement and kind of shelter used.

before totality, when the exposures begin; but we are not entirely dependent upon this, for the cusp will be watched, and again it has been calculated that this will extend through an arc of 45° at the same time (5 seconds) before totality. The arc will be watched to extinction in a 3¾-inch telescope, and this will enable the general signal "go" to be given.

Prof. Pedler has been here some days, and has got his 6-inch equatorial with grating spectroscope drill into perfect order. He begins 7 minutes before totality to repeat my Egyptian observations and studies certain special lines in the spectrum of the corona during totality. He has a comparison arc spectrum of iron, carbon, &c., photographed in the instrument before we came out.

NORMAN LOCKYER.

"A TRIP TO CANADA."

AMONG the more interesting and instructive results of the recent visit of the British Association to Canada, is the issue of a pamphlet entitled "A Trip to Canada" by a clergyman, who was one of the party.

The motives with which the journey was undertaken are given with a naïveté which commands respect. "The Jubilee of 1897," we are told, "naturally suggests the idea of a little foreign travel on one's own account. It is one thing to read about the Colonies; it is another to see them with one's own eyes. Where shall we go? There is a large choice. In these days there is a variety of Cook-like associations, which bid for one's patronage. This summer I was glad to take what came to hand. The British Association held its meeting last August in Toronto."

This is, indeed, a delightful picture. When the century was in the lusty hey-day of its youth and middle age, prelates and professors "gave and received hard knocks." Now, as the years roll on, science waits, hat in hand, on the country rector. His breakfast table is piled with the circulars of a "variety of Cook-like associations." As he cracks his egg he thinks of accompanying the geologists to Moscow and the Caucasus. A slice of cold ham recalls the Arctic Circle, the midnight sun and Thos. Cook. Then his vagrant fancy swerves to Grindelwald and Dr. Perowne. But with the first spoonful of marmalade he feels that the British Association and Toronto have secured the prize. He decides to patronise universal science and the British Empire.

The reasons for this decision were not less stupendous than the decision itself. Civilisation has travelled from east to west. "Let us," says the author, in a moment of pious aspiration, "let us follow in the track of Providence."

The idea of taking a "Cook-like" tour in "the track of Providence" strikes us as novel, and would, perhaps, have been thought to be profane had it emanated from Thos. Cook and Son themselves. Originating, as it does, with a clergyman, we can only bow the head and wonder at the varied manifestations of the religious instinct.

The alternative plans had been carefully considered, and the following sentences indicate the kind of information which had been collected. "The British Empire is composed of possessions in many parts of the globe. We hold India by military occupation; its 300 millions of people are put under our rule. Australia, New Zealand and Tasmania are in the Antipodes; Borneo, Singapore and the West Indies are in the tropics. Africa has various climes and races and interests. . . . Canada comes first among our possessions from a tourist point of view."

After this display of recondite knowledge, it will hardly be believed that one of the author's motives for taking a trip across the Dominion was that it improves one's geography; but this fact, reinforced by the arguments as to the "track of Providence" and the "tourist point of view" settled the matter, and to Canada our author went.

The journey once undertaken was as remarkable in its experiences as in its inception. "For the two first days [of the voyage]," says the traveller, "you feel more or less in a strange land." The feelings of the first two days are often so peculiar, that it is difficult to find words to describe them; but to feel "in a strange land" when you are really at sea is, we believe, a unique experience.

Arrived at the other side, "Quebec in electric light, as we gazed upon it, reminded me of Valetta between its two harbours, or even of Venice standing in its waters. It is commonly said to resemble Gibraltar." As we have always understood that there is a hill or cliff of some sort both at Gibraltar and Quebec, but that Venice is as flat as a pancake, we confess to being puzzled by this passage.

The first effect of Niagara on the traveller was exactly the opposite of that it ordinarily produces. "Niagara," he says, "makes one forget Lord Kelvin." The Horse Shoe Falls, we are told, "is a thing to see not once or twice, but to imbibe and sleep upon." The first of these phrases reminds us of the experiences of the young lady at Venice. "We have been out on the Grand Canal," she wrote, "drinking it all in. Life never felt so full before." We are not aware that there is any competitor for the originality of the idea of sleeping on the Horse Shoe Falls.

At Toronto our author's favourite subjects were geography and anthropology, but he "threw in a little geology and zoology." Prof. George Dawson will be sorry to hear that his address was dull; but Prof. Miall will be gratified by the following summary of his teaching: "He said you should not collect specimens and put them in bottles, but study their living habits."

We cannot follow the trip across the continent in detail.

Sometimes the author becomes didactic. "The old road [in the valley of the Frazer] is now disused, and the iron road has taken its place. . . . The two roads are a natural parable. The old road is like the way of the world, along which weary travellers toil and often lose hope. In the railway the voyageur (*sic*) travels safely and with rapidity. The cares of travel sit lightly upon him. He sleeps peacefully at night, and he enjoys the prospect by day. He looks on his journey's end with pleasure. He thanks . . ." But we refrain from giving the quotation which the author adds to this quaint specimen of moral reflection. The sleek tourist, carted about without any effort of his own except that of pulling his purse from his pocket, has never before, we suppose, been taken as the type of the "seekers after truth." The pioneer, hewing his way through the wilderness, careless if his road be rough or smooth is, we take it, much nearer to the conception which John Bunyan had formed of those who through the Slough of Despond, the Valley of the Shadow of Death, and the River itself, press forward to their goal.

One quotation more and we have done. We all remember the difficulty with which Martin Chuzzlewit escaped from the peremptory demand of Colonel Diver, "Let me ask you, sir, how do you like my country?"

Our author would have been equal to the occasion. "One is asked one's opinion about the country. That it is a great country is plain to all. A country of the size of Europe is not a small country. At present it is thinly populated. The Canadians think much of their country and everything in it. An enthusiastic young lady, whose home is in Ottawa, and who is on her way to a finishing school in London, said 'Don't you think the electric cars in Ottawa are better than anywhere else?' Of course they are, one cannot but reply, quite *boná-fide*. Would not she brighten an electric car, wherever she was?"

This is masterly. The judicial logic of the opening and the skilful retreat behind the young lady would have baffled Colonel Diver himself.

But enough of this. The note of the British Association is that it strives to bring the scientific expert into contact with the amateur, who is often a man from whom, on some special point, the expert may have much to learn. It is possible that some of those who are thus brought nominally within the scientific fold, care more for the cheap excursions and the "tourist point of view" than for the advancement of science. This is perhaps inevitable. At all events the Association has not chosen to attempt to sift the chaff from the grain, and the Canadians were willing to extend their generous hospitality not only to the group of well-known scientific workers who crossed the Atlantic, but to others whose only introduction was their Association ticket. As a member of the Association our author was everywhere kindly received, was carried across the continent half-price, and even enjoyed the pleasure (which he duly notes) of riding in electric trams for nothing. It might have been expected that he would have been grateful for the privileges which were extended to him in his presumed character of one anxious for the advancement of science. We have looked carefully through the pamphlet and find scarcely a single expression which gives evidence of any such sentiment. On the contrary he seems to think that the benefit was mutual. His last words are: "A trip to Canada is a pleasant experience. May I say that it gives pleasure to those whom one goes to see, as well as to the individual who makes the trip."

His scientific companions fare no better than his hosts. They are gracefully described as crossing the Atlantic "to disgorge their erudition well flavoured with salt." There is a contemptuous reference to "the smaller fry." A body which Sir John Evans, Lord Kelvin and Lord Lister were not ashamed to lead, is called "Cook-like." The author's whole attitude is that of a man who has paid his money, and has had no more than his rights.

We should not have dealt with this pamphlet at such length had it not been accompanied by a printed request for subscriptions for an object which many men of science would be glad to help. In his desire to benefit this object the author may give his work a wide circulation in this country and in Canada. We think it right, therefore, to draw attention to what otherwise might have been left unnoticed, in order to protest that this pamphlet must not be taken to represent the attitude of average members of the British Association.

None of them desired to imbibe Niagara, or are likely to forget Lord Kelvin. Amongst them there was the deepest feeling of gratitude for the hospitality they received; hospitality which the most distinguished acknowledged was more kindly and more lavish than they had any right either to expect or to desire.

THE HABITS OF ICE-SEALS.

THERE are four species of earless, or true seals inhabiting the boreal part of the North Atlantic and Arctic Oceans which may well be designated ice-seals, since they dwell for a considerable portion of the year either on the solid pack-ice or on ice-floes. These species are the Greenland or harp-seal (*Phoca grœnlandica*), often termed, on account of the conspicuous black markings on the yellowish-white ground-colour of the back, the saddle-back; the ringed seal (*P. hispida*); the large bearded seal, or square-flipper (*P. barbata*); and the crested, or hooded seal (*Cystophora cristata*), the males of which carry the peculiar dilatable sac on the nose from which the species derives its names. The first three of these are closely allied forms, but it is not a little remarkable that whenever the young of the first and second are born in a uniform yellowish-white coat, those of the third make their appearance in the world in a dark pélage; the white coat being not improbably shed *in utero*. It is commonly believed that the young of the fourth species are also white-coated, as are certainly those of the more southern grey seal (*Halichœrus grypus*). If a white coat serves as a protection to the new-born "pup" on the ice, it is difficult to see why this type of coloration should have been departed from in the case of one species. But the whole subject is one of great difficulty, as the white-coated young of the grey seal may often be seen in the Hebrides reposing on black rocks. All the four species in question agree in the circumstance that the young are produced during their sojourn on the ice; but in other respects very considerable differences are displayed in regard to habits.

In the first place, the Greenland and the crested seal are essentially migratory animals, the former associating in immense herds and the latter in smaller parties, whereas the bearded seal, which is considerably the largest of the three, only makes a slight movement to the south when compelled by the increase of the winter pack-ice, and is a comparatively solitary creature. But these are by no means the only points of difference in this respect. The Greenland seal visits the country from which it takes its name twice annually, namely in the autumn and the spring; and breeds chiefly on the coasts of Jan-Mayen and Newfoundland, the young being produced in the latter district at the beginning of March, but in the former some weeks later. That some of these seals which migrate from Greenland travel westwards to Jan-Mayen is most probable, but where the remainder pass their time while away from their native land, is not yet ascertained with certainty. The southern migration of these seals on the Atlantic coast of America, which commences when the frost sets in, is described as a wonderful sight; at first small advance parties pass down, and these are followed by the main body, which includes thousands of individuals, and takes about a couple of days in passing a given point. Although during their migration hugging the coasts, the Greenland seals during the breeding-season frequent the heavy floe-ice, at least in East Greenland, which is not liable to break up, and therefore affords them a safe habitation. As they have no difficulty in obtaining access to the water, in this district, at any rate, they do not make breathing-holes; and it has been commonly supposed that this is their invariable habit, but in a little pamphlet recently issued by Commander Robinson,[1] entitled "Ice-riding Pinnipeds," it is stated that when on solid thin ice such holes are made. In disposition this seal is mild and gentle; and it is a well-ascertained fact that the young are born in the white coat, the British Museum possessing a stuffed example in this state. From its numerical abundance it is commercially one of the most valuable of the true seals.

As regards the bearded seal, this, as already mentioned, is a comparatively rare and solitary species, fond of reposing on floating ice in the open sea, and moving southwards only when compelled by the extension of the pack-ice. It is apparently one of the species which does not make a breathing-hole, as it does not frequent large extents of ice; and it may generally be recognised at a distance by its habit of performing a somersault when diving into the water. In the pamphlet already referred to the suggestion is made that a certain number of the young of this species are infected by the migratory instinct of the young Greenland seals, and wander south with them. In addition to the testimony of sealers, a specimen in the Natural History Museum conclusively proves that the young "square-flipper" is born in the dark coat.

The ringed seal, which is common to the North Atlantic and Pacific, is a non-migratory species, whose favourite haunts are retired fjords and bays, in which it remains during the time they are tightly packed with ice. When, however, the ice breaks up, the "floe-rats," as they are called by the sealers, retire to the ice-floes, upon which the young are born in March and April. This species always form an "atluk," or breathing-hole in the ice, which is in the form of an oblique passage, through which the surface of the ice can easily be reached from below. The hole appears to be made while the ice is forming; but accurate accounts of the *modus operandi* are still required. In the above-mentioned pamphlet it is stated that the animal works on the ice with its front claws, revolving round this pivot with its body; but it is somewhat difficult to realise how such a method can be effectual, and, *primâ facie*, it would seem more probable that the passage is made while the ice is sufficiently thin to break with the weight of the seal, and kept open by constant use. The breathing-hole affords an easy method of capturing the seals which use it, and the great reduction in the number of these seals is largely due to this method of hunting.

As it differs much in external form from other ice-seals, so the crested seal has several peculiarities in habits. Unlike the others, it is a bad-tempered animal, living, except when driven to associate more closely by an unusual scarcity of ice, in small parties scattered over a wide extent of ice, always preferring the outside of the pack, or drift ice to the neighbourhood of land, and seldom frequenting either the coasts or isolated rocks. On the American side they are chiefly to be met with near the eastern edge of the main ice-pack, where there are numerous patches of open water, and consequently abundant room for fishing. Ordinarily small parties of from three to five individuals are scattered over the broken rough ice, at distances of from thirty to fifty yards apart. The easy access to water thus afforded obviates in general the necessity of making breathing-holes. They are stated to resemble fur-seals in being polygamous; and the males certainly engage in combats for the possession of the females, during which they utter loud cries which may be heard for miles. In winter these seals travel south, but they do not make the two annual journeys characteristic of the saddle-backs in Greenland. In European seas the crested seal has become comparatively rare, although on the American

[1] I am informed by the author that, owing to certain errors, all available copies of this work have been cancelled.

side, where its favourite haunts are Labrador and Newfoundland, it is still so abundant that many thousands are at times taken by a single vessel. March is the breeding-time, and at this season the young are produced on the ice far away from land. All previous writers with which we are acquainted state that the young are born in the white coat, which is not exchanged for the grey till the lapse of about twelve months. But Commander Robinson is positive that this is incorrect, and that the grey coat is assumed previous to birth. Unfortunately there are no specimens in the British Museum available for deciding this disputed point; but it is earnestly to be hoped that such may be supplied before long. In the meantime it may be suggested that the discrepancy has arisen from the young of one species having been mistaken for that of another, although it is at the same time difficult to see how this can have been the case with a seal so peculiar in appearance, and dwelling so much apart as does the present.

The above are but a few of the leading features in the habits of the northern ice-seals, to describe which in detail would require a small volume. Among the points which require special elucidation are what becomes of the great bulk of the harp-seals between their visits to Greenland in May and September, the mode in which seals make their breathing-holes, and the colour of the newly-born crested seal. R. L.

MAGNETIC AND PENDULUM OBSERVATIONS.[1]

IT may be remembered that Lieutenant Peary, before starting on his sixth expedition to Greenland in 1896, offered transport on his steamer to two parties of scientific men, and that the opportunity was very properly accepted. The parties—which were under the direction respectively of Prof. A. E. Burton, of the Massachusetts Institute of Technology, and Prof. R. S. Tarr, of Cornell University—consisted each of six members, and were entirely independent in organisation and equipment of the main body of the expedition. The researches of the Boston party consist of observations in terrestrial physics, including glacier phenomena, and studies of Eskimo life, and their reports are now coming to hand. The report of Mr. G. R. Putnam, of the United States Coast and Geodetic Survey, who undertook the magnetic and pendulum observations, is now before us.

Early in July Mr. Putnam left Boston with a complete outfit of magnetic, pendulum, and astronomical instruments, and arrived at Halifax, Nova Scotia, two days later. Here he found time to make magnetic determinations at the Naval Dockyard, at which station the declination observations cover a period of nearly three centuries. Reaching Sydney, Cape Breton, the starting point of the expedition proper, six days elapsed before the departure of the *Hope*, Lieutenant Peary's steamer, and in this time all the instruments were set up and used. The voyage along the Labrador coast was only interrupted by a few hours' stop at Turnavik, where magnetic observations were made. Passing up the Hudson Straits, Mr. Putnam spent two days at Ashe Inlet, but here a gale on the second night unfortunately interfered with the full success of his work. The *Hope* then turned eastward, and on August 1 the coast of Greenland was sighted. Magnetic observations only were made at Godhavn, and Umanak was reached a day or two after. Here Mr. Putnam's party landed and settled down for a month, while the *Hope* continued her northern voyage. The required observations having been completed, the whole party indulged in exploring trips, but on these excursions they could not well take the magnetic instruments. On the return of Lieutenant Peary, the homeward journey began. After the magnetic observations at Godhavn had been repeated, the ship anchored at Niantilik, in Cumberland Sound, where observations were again attempted, but here the value of the pendulum observations was lessened, because unfavourable weather did not allow the necessary time-observations. Sydney was again reached September 26, and here a few observations were taken, prior to the instruments being shipped to Washington, where they were tested and found to be unaffected by their long journey of 5000 miles.

The magnetic outfit, comprising a dip circle of the ordinary Kew pattern and a magnetometer, was lent by the Coast and Geodetic Survey. In the case of the latter instrument, the magnet consisted of a hollow octagonal prism of steel, held in a stirrup with a long arm to which the two silk fibres were attached. By this arrangement the magnet remained sensibly horizontal at ordinary latitudes, but a copper balancing ring was sometimes used at the most northerly stations. The formula used for computing the moment of inertia of this ring (p. 74) is incorrect, and the term $\frac{1}{3}(x_2^2+x_2x_1+x_1^2)$ should be replaced by $\frac{1}{4}(x_2+x_1)^2$, although the numerical correction happens to be insensible. For determining the azimuth by the sun, the magnet box is removed from the base and circle, and the latter is then used with a separate theodolite.

Mr. Putnam's results in this part of his work are both valuable and interesting. Further evidence has been obtained of the violence of magnetic disturbances in polar regions, although far greater disturbances have been recorded. Thus the range in a day observed at Niantilik exceeded $4\frac{1}{2}$ degrees, a change of over 3 degrees being noticed in twenty minutes. A comparison with the contemporary record at Washington reveals, it is true, that an unusual magnetic storm visited this city, but its severity as measured by the range of declination was fifteen times less than that at the northern station. With the exception of Niantilik, earlier information is available with regard to all the stations visited by Mr. Putnam; and although only Halifax and Godhavn possess satisfactory records extending over the last three-quarters of a century, the general tendency in the change of the magnetic elements seems to be clearly indicated. At present it appears that at all these points "the westerly declination is diminishing, the northerly dip is diminishing, the horizontal force is increasing, and the total force is diminishing."

The apparatus used for determining the relative force of gravity, comprised a set of three half-second pendulums, one sidereal and two mean time chronometers, and a meridian telescope. The pendulums were swung in an air-tight case, in which the pressure was reduced to about 6 cm. by means of an air-pump. All the chronometers were provided with electrical break circuit attachments, and were thus capable of the instantaneous raising of a shutter by an electrical mechanism and the momentary illumination of a slit every second or two seconds. By this means the reflections of a flash in two mirrors, one attached to the fixed knife edge, and the other to the head of the pendulum, could be observed in a telescope. The period of the pendulum was then deduced from the observed coincidences. At the southern stations coincidences were observed with sidereal seconds, but nearer the pole, with mean time seconds, on account of the decrease in the period of the pendulum. Whenever the plan could be carried out each pendulum was swung for a period of eight hours, both in reversed and direct positions, and star observations were made at the beginning and end of the forty-eight hours. The following table summarises the principal results (p. 103):—

[1] "The Scientific Work of the Boston Party on the Sixth Peary Expedition to Greenland. Report A."

Station.	Latitude N.	Longitude W. of Greenwich.	g_1, reduced to sea level.	g_0, theoretical value.	$g_1 - g_0$.
	° ′	° ′	cm.	cm.	cm.
Washington ...	38 53	77 1	980·101	980·087	+ 0·014
Sydney (Cape Breton) ...	46 9	60 12	980·722	980·732	− 0·010
Ashe Inlet ...	62 33	70 35	982·109	982·104	+ 0·005
Umanak ...	70 40	52 8	982·594	982·632	− 0·038
Niantilik ...	64 53	66 20	982·275	982·271	+ 0·004

The theoretical value is that given by the assumed formula,

$$g_0 = 978·066 \, (1 + 0·005243 \sin^2 \text{latitude}),$$

and g_1 is obtained by using Bouguer's formula.

It would not be easy to over-estimate the value of these accurate determinations of gravity, for they help to fill a very serious gap in the series of observations which have been made in various parts of the world. Prof. Helmert's recent report to the International Geodetic Association has shown that no pendulum observations had been obtained in the region visited by Mr. Putnam, and it is in the polar regions that data as to the variations of gravity are of the greatest importance and, therefore, most urgently required. Mr. Putnam concludes his report with some historical notes on the development of apparatus and the progress of research, which are very interesting. It is hardly correct, however, to say that the law $t = \pi \sqrt{\frac{l}{g}}$ applies even to the ideal simple pendulum (p. 110). These notes contain a good account of the controversy which has arisen about the appropriateness of the second term in Bouguer's formula for the reduction of g to sea level: $dg = \frac{2gH}{r}\left(1 - \frac{3\delta}{4\Delta}\right)$, where δ is density of matter lying above sea level, and Δ is the mean density of the earth. The value of pendulum observations as affording indications of surface density is insisted upon, and a practical application of the method is suggested. It is to be hoped that Mr. Putnam will see his project realised, by which the relative proportions of ice and rock in the great Greenland elevation may be determined by pendulum experiments.

RAINFALL OF THE UNITED STATES.

UNDER this title the Weather Bureau of the Department of Agriculture has published a bulletin containing a discussion of the observations obtained from the longest and most trustworthy rainfall registers in the United States, accompanied by annual, seasonal, and other charts. In addition to the usual tables of the mean monthly and annual precipitation, arranged according to geographical distribution, an important departure has been made by separately discussing the rainfall of the crop-growing season; for, as the author remarks, however valuable a knowledge of the water supply throughout the year may be, information as to the amount of rainfall available for agricultural purposes is possibly of greater consequence.

Another departure from the ordinary treatment of the subject is the discussion of the monthly distribution by districts and types according to natural boundaries. The conditions favourable for rainfall are chiefly (1) nearness to the ocean, (2) proximity to the track of storms, and (3) the position of mountain ranges. The rainfall of the North Pacific coast is quoted as an example of the combined effect of all three conditions, the distinguishing characteristic of this type being a wet season from October to March, and a practically rainless summer, except in Northern California and parts of Oregon and Washington. About half of the yearly fall occurs between December and February. The rainfall is discussed under twelve such types; we are unable to refer specially to each of these, but the chart of mean annual precipitation shows that there is a narrow belt on the north-west coast, extending from Cape Flattery on the north to midway of the Oregon coast on the south, and some distance inland, where the annual amount exceeds 50 and at some points 100 inches. Eastward and southward the annual fall diminishes, reaching a minimum on the lowlands and valleys between the Coast Range on the west and the Sierra Nevada and the Cascade Ranges on the east, where the amount in some cases does not exceed 10 inches, but in years of plentiful rainfall as much as 20 inches may fall in the best-watered parts. At Terrace (Utah), a station on the Central Pacific Railroad, the mean annual fall is only 4·3 inches, and in the driest year was as low as 0·7 inch. To the eastward of the Rocky Mountains the annual fall is from 10 to 18 inches, and increases slowly to 60 inches on the Florida and Gulf coasts, and from 40 to 50 inches in the Eastern States. There is, however, a gradual decline both from the Atlantic coast westward and from the Gulf coast northward. In considering the various rainfall values in this discussion allowance must be made for the position of the gauges which are generally exposed on roofs, owing to the stations being mostly in towns. It is well known that the amount caught in the gauge decreases with altitude above the ground, and it is estimated that the loss from this cause in the values quoted by the Weather Bureau is from 5 to 10 per cent. of the total annual fall. With regard to the important subject of excessive rainfall, down to the year 1888 only one self-recording gauge was in use at the Signal Service stations; five others were added in 1889, and the publication in the *Monthly Weather Review* of the maximum falls in five and ten minutes, and also in one hour, were begun. In August 1890 a cloud-burst passed over Palmetto (Nevada), when a gauge that was not exposed to the full intensity of the storm caught 8·8 inches of water in an hour, and in August 1891, 11½ inches were measured within an hour at Campo (California). The great majority of excessive rains are said to occur east of longitude 105° W., and principally in the summer months, in connection with afternoon thunderstorms; they occasionally take place in the track of West India hurricanes, and are more abundant on the Gulf and South Atlantic coasts than at inland places. The maximum rates of rainfall per hour, estimated from periods of five minutes, at the Weather Bureau Stations which possess self-registering gauges, were 9 inches at Bismarck (N. Dakota); 8·4 inches at St. Paul (Wisconsin), and 8·2 inches at New Orleans.

This valuable memoir has been prepared by Mr. A. J. Henry, under the direction of Prof. Willis L. Moore, the Chief of the Weather Bureau.

NOTES.

THE German Emperor, as King of Prussia, has conferred upon Dr. John Murray, Director of the Scottish Marine Station, and formerly of the *Challenger* expedition, the rare distinction of knighthood in the Order *Pour le Mérite* founded by Frederick the Great. This is generally allowed to be the highest honour which a man of science can receive, and is limited to thirty German and twenty-five foreign knights. Lord Kelvin, Lord Lister, and Sir G. G. Stokes are the only other British men of science now alive who have received the Order. Dr. Murray has also been elected a Foreign Member of the Imperial Russian Academy of Sciences.

THE Committee appointed by the American Society of Naturalists to inquire into the practicability and feasibility of the exploration of the Antarctic continent, report that an expenditure of from forty thousand to fifty thousand dollars would suffice for an independent scientific expedition. The Committee suggests that if this fund could not be raised by

public subscription, a number of scientific societies and institutions of general learning, should contribute the amount required, each sending representatives to the expedition in proportion to the sums subscribed.

WE are glad to hear that the Zoological Society of London has contributed 100*l.* towards the expenses of the International Congress of Zoology; and we hope to hear that other natural history societies have followed this excellent example.

SIR DYCE DUCKWORTH has been appointed to deliver the Harveian Oration before the Royal College of Physicians of London for 1898. Dr. G. V. Poore has been nominated Milroy Lecturer for 1899.

THE Council of the Institution of Civil Engineers have resolved that the "Engineering Conference," inaugurated in 1897, is to be biennial, and that, accordingly, the next meeting will be held in London in the spring of 1899.

A LARGE and representative Royal Commission has been appointed to advise as to the best means by which the products of British industry, agriculture, and the fine arts may be procured and sent to the International Exhibition to be held at Paris in the year 1900. Among the Commissioners, which include the Prince of Wales and the Duke of York, are the following representatives of science and the arts, in alphabetical order:—Sir F. A. Abel, Sir George Birdwood, Major-General Sir Owen Tudor Burne, Sir G. H. Chubb, Major-General Sir John Donnelly, Lord Kelvin, Sir James Kitson, Sir Trevor Lawrence, Lord Lister, Sir John Lubbock, Sir Clements Markham, Mr. W. H. Preece, Mr. E. Windsor Richards, Earl Spencer, Mr. W. T. Thiselton-Dyer, Sir E. Maunde Thompson, and Sir W. H. White.

M. FRANCHET has been elected President of the Botanical Society of France for the current year; MM. Zeiller, Boudier, Clos, and Roze Vice-Presidents.

PROF. O. MATTIROLO, of Bologna, has been appointed Professor of Botany and Director of the Museum and Botanical Garden at Florence; Prof. F. Morini, of Messina, takes his place at Bologna.

ON December 18, 1897, a hall was opened at Bologna for the reception of the herbaria, preparations, and sections of the botanist Aldrovandi. It has been erected at the cost of the city and province.

THE part of *Malpighia* comprising fascs. 9 and 10 for the year 1897, edited by Prof. O. Penzig, contains a view of the very handsome monument erected to the memory of Malpighi at Crevalcore.

THE post of Government botanist to Victoria, vacant by the death of Baron Ferdinand v. Müller, has been conferred on Mr. J. G. Luchman.

THE death is announced of Dr. Waldemar v. Schroeder, professor of pharmacology in the University of Heidelberg, and author of a number of treatises on physiological chemistry.

WE learn from *Science* that the Bruce gold medal of the Astronomical Society of the Pacific has been awarded to Prof. Simon Newcomb, for his distinguished services to astronomy.

THE American Academy of Arts and Sciences has elected M. Elias Metschnikoff, of Paris, Foreign Honorary Member in the Section of Zoology and Physiology.

THE twenty-sixth general meeting of the Federated Institution of Mining Engineers will be held at Newcastle-upon-Tyne on February 22 and 23.

AT the annual general meeting of the Royal Horticultural Society, held on Tuesday, the Council announced that they had appointed the Rev. George Henslow to be professor of botany to the Society, and that Prof. Henslow had kindly undertaken to give addresses at a number of the 1898 meetings, drawing attention to interesting points connected with some of the plants, &c., exhibited. The Council believe that these "demonstrations" will be greatly appreciated by the Fellows of the Society.

AT the general monthly meeting of the members of the Royal Institution, on Monday, the special thanks of the members were returned to Mrs. Tyndall for her liberal donation of 1000*l.*, presented in the name of the late Prof. Tyndall, for the promotion of science Thanks were also returned to Sir Frederick Abel, Sir Andrew Noble and Prof. Dewar for donations to the fund for the promotion of experimental research at low temperatures. It was announced that the centenary of the Royal Institution would be celebrated next year.

THE meeting of the Manufacturers' Association of America at New York, on January 25-27, was the most notable gathering of the masters of industry ever held in America, or probably in the world. It was estimated that the 966 persons who attended the closing banquet represented industries which produce 9,000,000,000 dollars of manufactures annually. In the meetings of the Association prior to the banquet the subject of the metric system was presented by the committee, together with a resolution strongly favouring it; which resolution met with support from many of the most influential members of the Association, but was opposed by the chairman of the committee on the grounds of the expense of making new gauges and tools in changing from the present standard. The final result was that the resolution was not carried.

FURTHER particulars of Prof. O. C. Marsh's valuable gift to Yale University (see p. 322) are given in the *Yale Alumni Weekly*. From a scientific point of view, the value of the collections now presented to Yale is beyond price, each one containing many specimens that can never be duplicated, and are already of historical interest in the annals of science. Among the prominent features of one of these collections, that of extinct Vertebrates, may be mentioned (1) the series of fossils illustrating the genealogy of the horse, as made out by Prof. Marsh, and accepted by Huxley, who used it as the basis of his New York lectures; (2) the birds with teeth, nearly two hundred individuals, described in Prof. Marsh's well-known monograph "Odontornithes"; (3) the gigantic Dinocerata, several hundreds in number, Eocene mammals described in his monograph on this group; (4) the Brontotheridæ, huge Miocene mammals, some two hundred in number; (5) Pterodactyles, or flying dragons, over six hundred in number; (6) the Mosasaurs, or Cretaceous sea-serpents, represented by more than fifteen hundred individuals; (7) a large number of Dinosaurian reptiles, some of gigantic size. Besides these are various other groups of mammals, birds, and reptiles, most of them including unique specimens.

IN referring to the priceless collections which have now become the property of Yale University, by Prof. Marsh's generosity, the *Alumni Weekly* remarks that Prof. Marsh is a Yale graduate of the Class of 1860. He is a nephew of the late George Peabody, and thus he secured the donation that gave Yale the present Peabody Museum, as well as a reserve building fund that then seemed adequate for future additions. After obtaining this great gift for Yale, Prof. Marsh served his *alma mater* faithfully, without salary, for thirty years, as professor of palæontology, refusing all offers to go elsewhere. Besides bringing together with untiring zeal these vast scientific

collections now presented to the University, Prof. Marsh has found time to describe many of the important specimens new to science, and make them known to the world in more than two hundred and fifty publications.

WE have been requested to announce that it is proposed to raise, by international subscription, a memorial fund to the late Prof. Edmund Drechsel, the well-known physiological chemist, whose recent death at Naples, on September 22, 1897, has been a great loss to science. Prof. Drechsel has left a widow and two young sons in very poor circumstances. It is hoped that sufficient money will be raised to contribute materially to the support and education of these boys, as well as to provide a modest memorial to Drechsel in the place where he is buried. Any contribution to this object may be sent direct to Prof. Kronecker, Physiologisches Institut, Bern; or to Mr. Ernest H. Starling, 8 Park-square, London, N.W., who will forward any subscriptions received to Prof. Kronecker. This appeal has been circulated among the members of the Physiological Society; but Drechsel was even more a chemist than a physiologist, and many English chemists, as well as other scientific men, may be glad to contribute in some way to the memorial which is being raised on behalf of his widow and children.

WITH reference to the recrudescence of epidemic influenza the *British Medical Journal* says:—Influenza has further increased in London during the past week, and medical practitioners in all parts of the town are finding their hands very full. The epidemic seems to be very prevalent also in some of the home counties, especially in Kent and Surrey, and it prevails also in Devonshire and Cornwall. The epidemic now prevalent, in some districts at least, differs in its character from those from which we have suffered in previous years. It has long been recognised that the disease may present at least three distinct types, according to whether it attacks most severely the respiratory, the nervous, or the digestive systems. In the earlier epidemics in recent years the majority of cases belonged to the first type, and many deaths were caused by bronchitis and pneumonia. Later, the prevalent type was the nervous, and men were left in a condition of mental and physical depression which for many months greatly limited their activities, and in too many cases helped to fill the asylums. The present epidemic is remarkable for the very large proportion of cases which show symptoms of profound disturbance of the digestive system.

IT is surprising that in a subject like mathematics, where any student may easily rediscover known theorems for himself, so few journals exist devoted to the interchange of notes and queries. We are glad to see that *L'Intermédiaire des Mathématiciens*, which exactly fulfils this object, has now entered on its fifth year of publication. The editors, Dr. C. A. Laisant and M. Émile Lemoine, justly take pride to themselves in recording that the recent Mathematical Congress in Zürich owed its origination partly to correspondence in their columns.

A NOTE by Commander C. H. Davis in *Terrestrial Magnetism*, calls attention to the serious effects of electric car disturbances at the magnetic observatory of the United States Naval Observatory, which is situated on Georgetown Heights, in the suburbs of Washington. The disturbances seem to have most affected the vertical force, but the horizontal force and declination were also disturbed. Experiments conducted at the magnetic observatory of Toronto, which is still in a worse predicament than this observatory, show that magnetic instruments must be removed to a distance of at least two miles before the disturbances of an electric railway cease to be apparent. Observations at Toronto have been discontinued. As Commander Davis remarks, it thus appears that the use of powerful electric currents for commercial purposes has destroyed the usefulness of the only two magnetic observatories on the North American continent.

THE *Aeronautical Journal*, which now enters on its second year of publication, bids fair to be a current record of all experiments on aeronautical matters as well as of devices, both practicable and impracticable, for navigating the air. Among the features of the current number are an account of Mr. Chanute's American experiments, and a translation of a paper, by Captain Moedebeck, on the German aluminium balloon which was experimented with on November 3 of last year, but was wrecked through becoming unmanageable. That never failing subject of controversy, the "soaring bird," is again brought forward, this time in a lengthy disquisition by Mr. G. L. O. Davidson. Mr. P. Spencer describes Mr. Pollock's balloon trip of October 12, 1897, across the Channel; and Mr. A. Lawrence Rotch, of the Blue Hill Observatory, contributes a note on "The Highest Kite Ascent." A glance at the list of patents applied for, and actually granted, will show that the "dark ages" of science have not yet entirely disappeared, so far as aeronautics is concerned.

A SMALL pamphlet, entitled "Natural Colour Photographs," has been received from the Natural Colour Photography Company, Ltd., Dublin; and though Prof. Joly's name is not mentioned in it, the process described is evidently the one we owe to his ingenuity. This process, it will be remembered, consists in using two screens: one—the "taking" screen—lined in orange, yellowish-green and blue; and the other—the "viewing" screen—lined in red, green and violet. The pamphlet just received is taken up with directions for using these screens, the former of which is employed to obtain the negative, while the latter—when superimposed upon the positive finally obtained—reproduces the colours of the original object, which appears as a transparent photographic image in the natural colours. Many photographers will be glad to know where to procure these screens, and how to obtain the best results with them.

AT the meeting of the Academy of Sciences at Vienna, on January 20, Dr. J. Hann communicated a treatise on the theory of the daily oscillation of the barometer. The chief object of the discussion is the investigation of that portion of the regular oscillation of the barometric pressure which occurs once in an entire day. This period is most subject to disturbances of locality and time because all meteorological phenomena have a whole-day period. With the view of eliminating all disturbing influences as much as possible, the author deals with the hourly observations made at sea, and on islands far from continents. Near the equator the extremes of the whole-day period occur near 5h. 30m. a.m. (the maximum) and 5h. 30m. p.m. (the minimum), which are not very different from the average conditions on land, the epochs being retarded with increase of latitude. The amplitude of the whole-day oscillation at the equator is nearly a third of that of the double daily variation. The amplitudes of the daily wave have two principal maxima at the time of the equinoxes, and a principal minimum in June and July, at the time of aphelion; while in December and January, at the time of perihelion, the amplitude is much greater. The author also investigates, for a number of stations, the modifications to which the normal whole-day wave of barometic pressure is subject, owing to the daily periodic transfer of masses of air from land to sea, and the reverse, as well as at mountain stations.

THE Hong Kong Observatory seems to have been originally founded for the purpose of issuing storm warnings and protecting commerce against the destructive typhoons which visit

those parts. Looked at from that point of view the Observatory seems to have fulfilled its original object. The Report for 1896, just received, gives a full account of the work carried on, and particularly analyses the relative success that has attended the weather and storm predictions issued. Adopting the general method of taking the sum of total and partial successes as a measure of success, and similarly with the failures, we learn that 97 per cent. of the weather forecasts have been justified. With regard to the success in predicting the approach of a typhoon, the percentage is nearly as good, if we leave out of account a peculiar storm, prevalent in the winter, called a "Norther," and of which it is impossible to publish any forecast till information is available from the interior of China and the northern ports. For instance, there appears to be no telegraphic communication between the Observatory and either Hankow or Cheefoo, so that all information from a particular direction is wanting, which, if it could be obtained, would add materially to the safety of the shipping and commerce. But notwithstanding these disadvantageous circumstances, the percentage of success is 75 for all gales, and leaving out those for whose successful prediction northern information is necessary, the percentage is as high as 83. Among the original inquiries prosecuted at the Observatory is one on anemometer records at various altitudes. Two Robinson anemometers of identical construction are mounted at 150 feet and 1834 feet above mean sea-level. The lower is at the Observatory on the Chinese mainland, the higher on the island of Hong Kong. The result is to show the ratio between the force of the wind at the two stations for each hour of the day throughout the year. In the summer, when the wind is generally southerly, the proportionate velocity is greater than in winter, when the wind is easterly. Similarly at midnight, and the morning hours, the difference of velocity is greater than at noon, and the hours immediately after.

The *Pharmaceutical Journal* is doing its best to encourage the use of the metric system by pharmacists in their daily business. Recent legislation has made the use of the system legal in British commerce, but, as our contemporary points out, the mischief of a permissive system is that what is permitted is often, as a matter of convenience, ignored; and there is little doubt that the mere permission to use metric weights and measures in trade will prove futile in encouraging the general adoption of the system. The suggestion is offered, therefore, that pharmacists should neglect no opportunity of familiarising themselves, and those with whom they come in contact in the course of their business, with the more rational weights and measures that are now legal, the more especially as they appear destined, sooner or later, to supplant the older weights and measures entirely. With the view of encouraging and assisting the reform indicated, it is proposed in future to give all quantities in the pages of the *Pharmaceutical Journal* in accordance with the metric system, and the change will be effected in its entirety at as earlier a period as may prove convenient. After the new Pharmacopœia is published, there will be no excuse for British pharmacists to plead unfamiliarity with the metric system.

Among the more valuable incidental results of the Canadian meeting of the British Association must be reckoned the advances in our knowledge of the surface life of the North Atlantic, made by members of the Association during their outward and homeward voyages. We have referred in earlier numbers to the collections of plankton made by Prof. Herdman along the Canadian transatlantic route, and by Mr. Garstang along the Canadian and American routes. Prof. Herdman's account of his work is the first to appear, and has been published as a memoir in the *Transactions* of the Liverpool Biological Society (vol. xii.), under the joint authorship of Prof. Herdman, Mr. J. C. Thompson, and Mr. Andrew Scott. The memoir reveals a remarkably wide distribution for the majority of the forms enumerated. Four new species of Copepoda are described, three of them from the St. Lawrence and one from Puget Sound on the Pacific Coast. The discovery of these forms by English visitors should encourage Canadian naturalists to take up this promising field of research for themselves.

In order to obtain positive data as to the results of the serum treatment of diphtheria in Russia, the two St. Petersburg societies, of Children's Physicians and of Russian Physicians, nominated a special committee which studied all that had hitherto been printed in Russia on the subject, and entered into correspondence with the doctors who had used serum in their practice. An elaborate report of the committee was read, on December 24 last, by Dr. Rauchfuss before a meeting of the Society of Russian Physicians. In 44,631 registered diphtheria cases in which serum was used, the mortality was only 14·6 per cent., while in 6507 cases where no serum was used, the mortality was more than double, *i.e.* 34 per cent. By a careful analysis of data taken from 51 provinces of Russia, Dr. Rauchfuss shows that in each province separately the serum treatment had the effect of at once notably reducing the mortality, even in the midst of severe epidemics. He does not deny that medical help is now applied for in a number of lighter cases, in which no doctor would have been called for a few years ago; but the marked difference between the mortality in the cases which were treated with serum and those which were not, cannot be explained in this way, while the confidence of the population, including the peasants, in the new treatment is also a testimony in favour of it. Eleven laboratories situated in different parts of Russia are now preparing diphtheria serum.

It is now recognised that properly-organised and equipped museums are valuable factors in education, and render good service in directing and stimulating scientific work. Unfortunately, owing to general lack of means, and a staff the members of which have not received sufficient training, provincial museums are often of no service to education or to science. In *Natural Science* (December 1897), Mr. Herbert Bolton refers to these museums, and points out that hardly any two can be said to work upon a common plan, whilst most develop and exist rather as the sport of circumstances than as the outcome of definite purpose and design. What is badly wanted is the creation of an annual museums' grant by Government in aid of provincial museums of University Colleges, and of large cities possessing good collections and a trained staff, the sum allotted to each being determined by considerations similar to those which guide the application of the present University Colleges' grant. Upon the strength of such a grant the Government could charge each museum with a definite scope of work and the attainment and retention of a certain standard of excellence. It is also suggested that other museums might be subsidised through the agency of Council Councils, upon certificates of efficiency and progress received annually from an accredited visitor, who might be an official of the Government or of one of the first-class museums, Mr. Bolton's scheme of classification of museums, and of the work these institutions might do, should assist in directing attention to an important subject.

M. J. Deniker (*Bulletins de la Société d'Anthropologie de Paris*, 1897, fascicules 3 and 4), in a paper of considerable length, briefly mentions the characteristics of the inhabitants of the various districts of Europe. If three variants (cephalic index, measurement of stature, and colour of skin and hair) be each classified under three headings, twenty-seven combinations may result: as a matter of fact only six occur in considerable numbers, while four more in lesser numbers. The conclusion

that only six primary races (excluding Turks, &c.) inhabit Europe, with four secondary, the latter in smaller numbers and probably due to mixtures of the primary. These races he characterises and names:

(1) Blond, dolichocephalic, very tall ...	North-western race.
(2) Blond, sub-dolichocephalic, short	Eastern race.
(3) Brown, very dolichocephalic, very short	Ibero insular.
(4) Brown, very brachycephalic, short	Western race.
(5) Brown, sub-dolichocephalic, tall..	Atlanto-Mediterranean.
(6) Brown, brachycephalic, tall ...	Adriatic.

The four secondary races:

(α) Blond, mesocephalic, tall ...	Eastern Prussia.
(β) Blond, mesocephalic, very short...	Sweden.
(γ) Medium, sub-dolichocephalic, tall	Ireland, Belgium.
(δ) Auburn, sub-brachycephalic, medium	Holland to Bavaria.

THE first number of a new volume of *The Naturalist*, that old-established and admirable little monthly journal of natural history for the north of England, marks the disappearance of its former slate-grey wrapper and the substitution of a pink one, together with sundry improvements in type and setting, and the introduction of paper better adapted for illustrations. Altogether the editors are to be congratulated on the changes they have brought about.

WE have received from Messrs. Carl Zeiss, of Jena, a catalogue of microscopes and one of photographic objectives. The former does not describe any new kind of instrument, but in the latter an interesting feature is the new "Planar" lens. It is claimed that, with this, objective enlargements can be obtained of microscopic sections up to 100 diameters, so that it should prove extremely useful to botanists and others whose preparations demand the use of a lens having a large field and great covering power.

THE additions to the Zoological Society's Gardens during the past week include a Dingo (*Canis dingo*, ♂) from Australia, presented by Mr. D. R. McDowall; a Long-legged Buzzard (*Buteo ferox*), a Kestrel (*Tinnunculus alaudarius*), captured in the Red Sea, presented by Mr. J. Kilpatrick; a Golden-naped Amazon ((*Chrysotis auripalliata*) from Central America, presented by Mr. Gambier Bolton; two Red Ground Doves (*Geotrygon montana*) from South America, presented by Lady Blake; a Dinker Bok (*Cephalophus grimmi*) from West Africa, presented by Mr. L. H. Nott; a Salvadore's Cassowary (*Casuarius salvadori*) from New Guinea, a Salvin's Amazon (*Chrysotis salvini*), a Blue and Yellow Macaw (*Ara ararauna*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, deposited; two Black Larks (*Melanocorypha peltoniensis*) from Siberia, purchased; two Axis Deer (*Cervus axis*, ♀ ♀), a Pink-headed Duck (*Rhodonessa caryophyllacea*, ♂), an Indian Crow (*Corvus splendens*), four Spotted Turtle Doves (*Turtur suratensis*), two Brown-headed Gulls (*Larus brunneicephalus*) from India, received in exchange.

OUR ASTRONOMICAL COLUMN.

PLANETARY RELATIONS.—In *Comptes rendus*, of January 17, M. Émile Anceaux gives a note on the four great planets, and some new deductions relating to them. The four great planets—Jupiter, Saturn, Uranus, and Neptune—possess between them more than 99/100 of the known planetary mass; whilst Jupiter and Saturn alone have a total mass greater than 9/10 of this. It seems natural, then, to consider the system of these four planets as a world apart and independent of the other planets relatively small, and separated by a band of telescopic planets smaller still. The author considered, therefore, whether, by reason of their importance, the masses of the four great planets would not have some influence upon their distribution with respect to their distances from the sun. Some of the most interesting deductions are as follows:—

The masses of Jupiter and Saturn are inversely proportional to the squares of the major axes of their orbits.

The mass of Jupiter is to the sum of the masses of Uranus and Neptune as the inverse square of the major axis of Jupiter's orbit is to the sum of the inverse squares of the major axes of Uranus and Neptune.

The mass of Jupiter is to the sum of the masses of the four planets as the inverse square of Jupiter's major axis is to the sum of the inverse squares of the major axis of the four planets.

The mean moments of inertia of Jupiter and Saturn referred to the sun are equal to each other.

The mean acceleration of the solar attraction on Jupiter is to the sum of the mean accelerations produced upon Uranus and Neptune as the mass of Jupiter is to the sum of the masses of Uranus and Neptune.

The reason of this harmony may be in the conditions of stability of the system, or in the circumstances which prevailed at the formation of the planets. If this last cause be possible, the study of these relations would not fail to throw some light upon the cosmogony of the solar system.

U PEGASI AND SHORT-PERIOD VARIABLES.—The telescopic variable known as U Pegasi, which was discovered by Chandler in 1894, has for a long time been thought to have the shortest period of all variable stars, but observations made at the Harvard College Observatory go to prove that this is not the case.

Prof. Pickering, in *Circular* No. 23, from the above Observatory, gives the results of the observations made by Mr. O. C. Wendell with the polarising photometer, and states that the discrepancies between various observers, as to the period of the star, made it desirable to determine the true form of the light curve photometrically.

Mr. Wendell began his observations on December 28 of last year, using, as comparison, the star $+15°.4916$, mag. 8·90, which is only 15′ distant. From 2784 settings of the photometer he constructed a light curve, from which it soon became evident that alternate rather than successive minima were alike; the magnitudes at principal and secondary minima being 9·90 and 9·75 respectively. The light curve thus drawn, closely resembles in form that of β Lyræ, having nearly equal maxima, with magnitudes of about 9·30, and a period of 8h. 59m. 41s., the secondary minimum occurring nearly midway between the two primaries.

This period, it will be seen, is considerably different from that of 5h. 32m. 15s., as given by Mr. Chandler; but Prof. Pickering points out that, taking either value, the phases recur at nearly the same times every three days. If we neglect the difference between the primary and secondary minima, reduce the half-period to fractions of a day, and multiply it by 16, we obtain the product 2·99824d., or very nearly three days. If we multiply the period 5h. 32m. 15s. by 13, we obtain 2·99948d., or very nearly the same quantity. Accepting this new result, it appears that U Pegasi is no longer the variable star having the shortest period known. This position appears to be held by the variable ω Centauri 19, discovered by Prof. Bailey, who finds its period to be 7h. 11m. Although U Pegasi can no longer be regarded as an example of that peculiar class of short-period variables, having a single maximum in which the decrease is more rapid than the increase, this class is still represented not only by S. Antliæ, but by ω Centauri 24, which Prof. Bailey finds to decrease twice as rapidly as it increases, while ω Centauri 45 increases at least five times as fast as it diminishes.

WINNECKE'S COMET, *a* 1898.—The ephemeris of this comet is continued in the *Astronomical Journal* (No. 425) from February 7 to March 31, but for the purpose of observation it will suffice to give positions as far as the end of February; for after then the comet will be too near the sun to be conveniently observed.

Ephemeris for Greenwich Midnight.

1898.	App. α h. m. s.	App. δ ° ′ ″	log Δ
Feb. 7·5	17 54 3·34	−12 1 18·5	0·1457
9·5	18 4 0·23	21 40·1	
11·5	14 2·88	40 49·7	0·1400
13·5	24 12·71	−12 58 42·2	
15·5	34 28·36	−13 15 12·5	0·1356
17·5	44 49·18	30 15·4	
19·5	18 55 14·35	43 47·1	0·1326
21·5	19 5 43·16	−13 55 43·1	
23·5	16 14·76	−14 6 0·8	0·1310
25·5	26 48·40	14 36·4	
27·5	19 37 23·22	−14 21 28·2	0·1307

ASTRONOMICAL ANNUAL FOR 1898.—We have just received a copy of the sixty-fifth *Annual* of the Belgian Royal Observatory for 1898. The volume is similar in character to the many astronomical annuals published on the continent, giving in calendar form the most important astronomical events of the present year, and in addition geographical data referring chiefly to Belgium. Besides these there is a detailed description of the Royal Observatory at Uccle, together with the instruments and the observations made at the observatory in 1897.

SPECTRUM RESEARCHES OF η AQUILÆ.—Prof. A. Belopolsky has recently completed a new series of photographs in connection with the spectrum of η Aquilæ; and his paper on "Researches on the Spectrum of the Variable Star η Aquilæ" appears in the *Astrophysical Journal*, December 1897. In all, twelve photographs were taken corresponding to the different phases of brightness, and by an "iron comparison" on each photograph, it has been possible to determine the velocity of the system with respect to the sun.

The spectrum of η Aquilæ is remarkably like that of the variable star δ Cephei, belonging to a group of which γ Cygni is the type; therefore some of the principal iron lines contained in its spectrum have been utilised in making the measures.

From these measures, the author finds the motion of the system = − 1·85 geographical miles, and from the curve of velocities in the line of sight he concludes "that the times of minimum brightness and the times for which the velocity in the line of sight is zero do not coincide. For this reason the changes in the brightness of the star cannot be explained as the result of eclipses, and some other explanation must be sought." It is very remarkable that Prof. Belopolsky found this was also the case with the variable star δ Cephei.

A SIXTH edition of Mr. Thynne Lynn's handy little book on "Remarkable Comets" has just been published by Mr. Edward Stanford. The information in the book is completely up to date, even the observed return of Winnecke's comet, first seen on the present visit on January 2, being recorded. Encke's comet (period $3\frac{1}{3}$ years) may be expected shortly, and in the summer, Wolf's comet (period $6\frac{3}{4}$ years) should pay us a visit.

THE REFRACTION OF ELECTRIC WAVES.[1]

TWO years ago, Prof. Bose, in a communication to the Asiatic Society of Bengal, described some new devices for dealing with electric waves, which did much to bridge over the gulf between electric waves and light waves. One of these was the employment of nemalite, a fibrous variety of brucite, which has the valuable property of absorbing electric waves vibrating in a certain plane, and transmitting all waves at right angles to that plane. It thus could be made to do for electric radiation what a plate of tourmaline does for light, except that the directions of absorption and transmission are reversed. Nemalite is therefore a very convenient polariser and analyser of electric waves. Tourmaline also acts in the same manner (with planes reversed), but not to any extent comparable with the efficiency of nemalite. The apparatus was subsequently exhibited and worked before the Liverpool meeting of the British Association.

In the present papers, Prof. Bose describes some experiments on the refractive index of glass for electrical waves, carried out for the purpose of testing Maxwell's relation $K = \mu^2$, which maintains that the specific inductive capacity for any substance equals the square of its refractive index.

This relation, originally a purely theoretical deduction from an unproved theory, has been gradually verified as our experimental resources gained in power to grapple with the various difficulties involved in the measurements. In the first place, the specific inductive capacity is not a fixed number, but varies with the nature of the electric charge, whether stationary or alternating, and, if the latter, with the frequency of the alternations. Strictly speaking, Maxwell's relation only applies to the refractive index for waves of infinite length, and determinations of the optical refractive index. *i.e.* the index for electromagnetic waves of about 1/50,000th of an inch, do not bear upon the question. It is only the long invisible electromagnetic waves which can be properly used to test the relation.

TESTING MAXWELL'S RELATION.

The specific inductive capacity of glass has been assigned various values ranging from 2·7 to 9·8. The optical refractive index μ is about 1·5. Prof. Bose determined μ for electric vibrations of a frequency of about 10^{10} vibrations per second. The apparatus used is shown in the diagram.

It closely resembles an optical apparatus. The radiator, consisting of two platinum beads with a platinum sphere between them, and fed by an induction coil, is enclosed in the square box. The rays pass through the diaphragm P to the semi-cylinder C of the glass to be investigated. This semi-cylinder is turned until the rays are totally reflected by the back surface. They are detected by the receiver R, containing metallic filings, whose resistance is reduced by the impact of the waves. The shielding of the receiver from strong radiations is a matter of some difficulty. Prof. Bose says:—

"Another troublesome source of uncertainty is due to the action of the tube which encloses the receiver. When a slanting ray strikes the inner edge of the tube, it is reflected and thrown

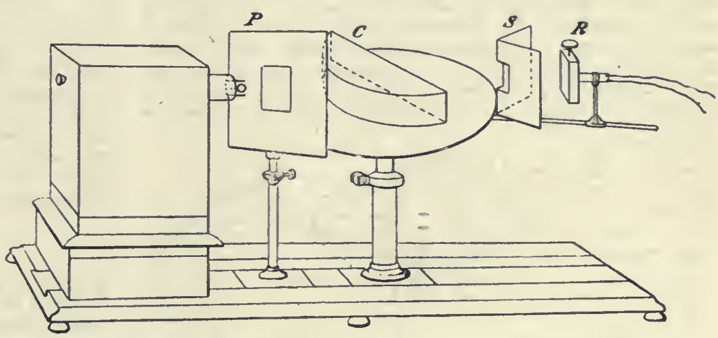

FIG. 1.—The electric refractometer: P, the plate with a diaphragm; C, the semi-cylinder of glass; S, the shield (only one shown in the diagram); R, the receiver.

on to the delicate receiver. Unfortunately it is difficult to find a substance which is as absorbent for electric radiation as lamp-black is for light. Lamp-black in the case of electric radiation produces copious reflection. I have tried layers of metallic filings, powdered graphite, and other substances, but they all fail to produce complete absorption. The only thing which proved tolerably efficient for this purpose was a piece of thick blotting paper or cloth soaked in an electrolyte. A cardboard tube with an inner layer of soaked blotting paper is impervious to electric radiation, and the internal reflection, though not completely removed, is materially reduced. No reliance can, however, be placed on this expedient, when a very sensitive receiver is used.

"After repeated trials with different forms of receiving tubes, I found a form, to be described below, to obviate many of the difficulties. Instead of a continuous receiving tube, I made two doubly inclined shields, and placed them one behind the other, on the radial arm which carries the receiver. The first shield has a tolerably large aperture, the aperture of the second being somewhat smaller. The size of the aperture is determined by the wave-length of radiation used for the experiment. It will be seen from this arrangement, that the rays which are in the direction of the radial arm, can effectively reach the receiver, the slanting rays being successively reflected by the two shields. With this expedient, a great improvement was effected in obtaining a definite reading.

"When the deviated rays are convergent, the receiver is simply placed behind the shields, at the focus of the rays. But when the rays are parallel, the use of an objective (placed behind the first shield) gives very satisfactory results. As objectives I used ordinary glass lenses; knowing the index from my experiments, I was able to calculate the focal distance for the electric

[1] Abstract of two papers communicated to the Royal Society by Prof. Jagadis Chunder Bose, M.A., D.Sc., Calcutta: "On the Determination of the Indices of Refraction of various Substances for the Electric Ray," and "On the Influence of the Thickness of Air-Space on Total Reflection of Electric Radiation."

ray. This is of course very different from the focal distance for the luminous rays. I at first used a lens of 6 cm. electric focal distance, but this did not improve matters sufficiently. I then used one with a longer focus, *i.e.* 13 cm., and this gave satisfactory results."

The value obtained for μ was 2·04, while the optical refractive index for the D line was 1·53. According to Maxwell's relation, the specific inductive capacity K should therefore be $4·16 = \mu^2$, a value well within the extremes of 2·7 and 9·8 mentioned above. It is interesting to note that the refractive power of glass is higher for these electro-magnetic waves than for light, and that ordinary lenses must therefore converge these waves to a shorter focus. Hence the small dimensions of Bose's apparatus.

Total Reflection of Electric Waves.

These and some of the earlier experiments were repeated with two semi-cylinders separated by an air-space, and the thickness of air necessary to produce total reflection was determined. In optics, a very thin film of air suffices. In the case of electro-magnetic waves as produced in the laboratory, the thickness is found to reckon by several millimetres.

Two semi-cylinders of glass, with a radius of 12·5 cm., were placed on the spectrometer circle. The plane faces were separated by a parallel air-space. The radiator was placed at the principal focus of one of the semi-cylinders; the rays emerged into the air-space as a parallel beam, and were focussed by the second semi-cylinder on the receiver placed opposite the radiator.

The two semi-cylinders were separated by an air-space 2 cm. in thickness; this thickness was found to be more than sufficient for total reflection. The experiments were commenced with an angle of incidence of 30° (slightly greater than the critical angle). The receiver, which was placed opposite the radiator, remained unaffected as long as the rays were totally reflected. But on gradually diminishing the thickness of air-space by bringing the

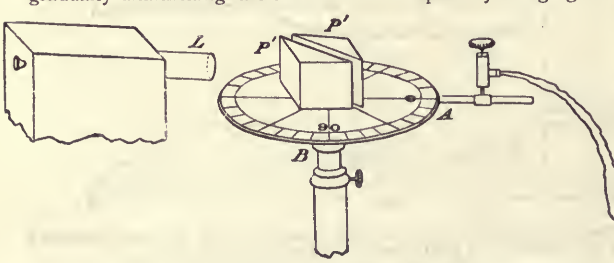

Fig. 2.—L is the lens to render the incident beam parallel; P, P', are the right-angled isosceles prisms; A and B are the two positions of the receiver. The receiver-tube is not shown in the diagram.

second semi-cylinder nearer the first (always maintaining the plane surfaces of the semi-cylinders parallel), a critical thickness was reached when a small portion of the radiation began to be transmitted, the air-space just failing to produce total reflection. The *beginning* of transmission could easily be detected and the critical thickness of air determined with tolerable accuracy. The slight discrepancy in the different determinations was due to the unavoidable variation of the sensitiveness of the receiver. When the thickness of air was reduced to 14 mm. the receiver began occasionally to be affected, though rather feebly. But when the thickness was reduced to 13 mm. there was no uncertainty; a measurable, though small, portion of the radiation was now found to be always transmitted.

With an angle of incidence of 60° the minimum thickness for total reflection was found to be between 7·6 mm. and 7·2 mm. The minimum effective thickness is thus seen to undergo a diminution with the increase of the angle of incidence.

The author also determined the influence of wave-length, using three different radiators.

The following method of experimenting was adopted as offering some special advantages. If a cube of glass be interposed between the radiator and the receiver placed opposite to each other, the radiation striking one face perpendicularly would be transmitted across the opposite face without deviation and cause a response in the receiver. If the cube be now cut across a diagonal, two right-angled isosceles prisms will be obtained. If these two prisms were now separated slightly, keeping the two hypothenuses parallel, the incident radiation would be divided into two portions, of which one portion is transmitted, while the other portion is reflected by the air film in a direction at right angles to that of the incident ray, the angle of incidence at the air-space being always 45°. The transmitted and the reflected portions would be complementary to each other. When the receiver is placed opposite to the radiator, in the A position, the action on the receiver will be due to the transmitted portion; but when the receiver is placed at 90°, or in the B position, the action on the receiver will be due to the reflected portion. The advantage of this method is that the two observations for transmission and reflection can be successively taken in a very short time, during which the sensitiveness of the receiver is not likely to undergo any great change. In practice three readings are taken in succession, the first and the third being taken, say, for transmission and the second for reflection.

When the prisms are separated by a thickness of air-space greater than the minimum thickness for total reflection, the rays are wholly reflected, there being no response of the receiver in position A, but strong action in position B. As the thickness is gradually decreased below the critical thickness, the rays begin to be transmitted. The transmitted portion goes on increasing with the diminution of the thickness of air-space, there being a corresponding diminution of the reflected component of the radiation. When the thickness of the air-space is reduced to about 0·3 mm., no reflected portion can be detected even when the receiver is made extremely sensitive. The reflected component is thus practically reduced to zero, the radiation being now entirely transmitted; the two prisms, in spite of the breach due to the air-space, are electro-optically continuous. This is the case only when the two prisms are made of the same substance. If the second prism be made of sulphur, or of any other substance which has either a lower or a higher refractive index, there is always found a reflected portion even when the two prisms are in contact.

The results obtained show that the effective thickness of the air-film increases with the wave-length. This was to be expected, since at very small wave-lengths, such as those of ordinary light, the thickness required for total reflection becomes very small. The brilliant reflection in the crack of a pane of glass is a familiar example.

PALÆOLITHIC MAN.[1]

IN the address of last year the evidence for the existence of man in the Tertiary period was reviewed, and although some of the evidence was very cogent, yet in no case did it amount to a proof, such as is necessarily demanded before so great an antiquity can be accepted for the human race. On the other hand, the presence of man in Quaternary times has long since been proved by the presence of many undoubted flint implements, in cave and river deposits of Pleistocene age and in relation with the bones of the mammoth and other extinct mammalia.

But other questions have now to be answered. What were the physical and intellectual peculiarities of the men who made the palæolithic implements? Have any parts of his skeleton yet been found?

Human bones and skeletons, more or less imperfect, supposed to be of Pleistocene age, have often been recorded both in this country and also on the continent of Europe; but a close investigation has, in most cases, proved them to be of much more recent origin, or has shown that there were very grave doubts as to their authenticity.

Much has been done to eliminate the doubtful records by such writers as Prof. Boyd Dawkins, M. Gabriel de Mortillet, and MM. Fraipont and Lohest; and consequently it is only necessary, at the present time, to consider the more important of these discoveries, and especially those which have been made within the last ten or fifteen years.

The famous Canstadt skull, described by Jaeger in 1835, is of uncertain origin, for when the mammalian remains, with which it was supposed to have been associated, were first described in the year 1700, no mention was made of this skull, and it is therefore by no means certain that it was associated with these extinct mammals. A new interest is awakened in this and some other of the earlier and unauthenticated remains of man by the discovery, within the last twelve years, of very similar skulls which are accepted as of palæolithic age. The skull discovered by M. Faudel in 1865, at Eguisheim on the Lower Rhine, is not unlike that from Canstadt, and is generally believed to be of

1 Abstract of Presidential Address to the Geologists' Association, delivered at the Annual Meeting, February 4, by Mr. E. T. Newton, F.R.S.

Pleistocene origin, while that from Engis, described by Schmerling in 1833, is evidently much more recent. The origin of the well-known Neanderthal calvaria has always been doubtful, but its extraordinary heavy brows and low forehead gave it an interest at the time of its discovery, which is not lessened now that very similar skulls have been found under better authenticated conditions.

The Moulin Quignon jaw, which created so much discussion for a few years after its its discovery in 1863, has long since been put aside as lacking authenticity. But the jaw found by M. Dupont in the Naulette cave is accepted as that of a human being that lived with the mammoth. The human bones from the caves of Aurinac, Cromagnon, Frontal, Mentone, and some others were shown by Prof. Boyd Dawkins to be of neolithic age. The skeleton found at a depth of thirty-two feet at Tilbury Docks in 1883 was thought by Sir R. Owen to be of palæolithic age, but Mr. T. V. Holmes has shown that those gravels are of comparatively modern origin, and could not be older than neolithic.

A fresh impetus was given to the study of palæolithic man by the memoir of MM. Fraipont and Lohest, who in 1887 gave an account of two remarkable skeletons found at Spy, in the province of Namur, Belgium. These skeletons are accepted as of the same age as the extinct mammals, with the bones of which they were found associated. The skulls are of a low type, and one of them especially makes a very close approach to that from the Neanderthal, not only in the general form, but also in the great development of the brow ridges and the lowness of the forehead.

A single tooth from Pont Newydd cave, St. Asaph; a piece of a skull from the brick-earth of Bury St. Edmunds, and parts of a skeleton from the high terrace-gravel of Galley Hill, Northfleet, are believed to be the only well-authenticated instances of palæolithic human remains yet found in Britain; and it is only the skeleton last named that is sufficiently well-preserved to give any idea of the form of the skull or limb-bones. The Galley Hill skull is very long and narrow, the brow ridges are strongly developed and the forehead is low, but not so depressed as in the Neanderthal calvaria. Although it may not be correct to include the Java Pithecanthropus in the genus Homo, yet as it holds an intermediate position between the lowest type of human skull, —the Neanderthal—and that of certain apes, it cannot be neglected when considering the early progenitors of man and its position in the geological series at the beginning of the Pleistocene, if not in the Pliocene, is precisely the place where such an ancestor would be expected to appear.

Although the greater number of the human remains supposed to be of palæolithic age are now known to be of more recent origin or are not well substantiated, yet there are a few which may be accepted as in all probability representatives of the men who made the palæolithic implements. In the latter category may be placed the skeletons from Spy and that from Galley Hill, as well as the jaw from Naulette and the piece of skull from Bury St. Edmunds. The Eguisheim skull and a few other remains found on the continent of Europe should perhaps be included with these. The famous calvaria from Neanderthal and Canstadt are among the remains of uncertain origin, but, on account of their resemblance to the Spy skulls, are supposed to be of the same age, and to belong to the same race.

If we accept the Spy, and other skeletons, as the remains of the men who made the palæolithic implements, what do they tell us of the mental and physical condition of those early progenitors of mankind? As a gauge of intellectual capacity, we have to confess that their skulls tell us far less than do the relics of their handiwork.

Prof. Huxley's dictum regarding the Spy men was that "the anatomical characters of their skeletons bear out conclusions which are not flattering to the appearance of the owners." They were short and powerful, but must have walked with a bend at the knees. Their skulls were depressed, with strong brow ridges and lower jaws of brutal depth. The Neanderthal skull has been said by the same authority to be the most ape-like of human crania yet discovered. At the same time it is highly probable that these palæolithic men were not less intelligent than some of the savage races living at the present day, for their brain capacity seems to have been as great as that of average Hottentots and Polynesians; and with an equal volume of brain we may presume there was an equal intellectual power. Moreover, men of no mean intellectual capacity are known to have possessed skulls of the Neanderthal type.

It may be doubted whether we are right in regarding the Neanderthal type of skull as typical of the palæolithic race, for other skulls referable to this period are less marked in character, and appear to indicate a greater range of form within the race than has usually been supposed. At present we have too few examples to allow of any definite deductions being made; but what we do know, points to the palæolithic race having had long skulls (dolichocephalic), in which particular they approach the neolithic race; but differ from them in the greater development of their brow ridges, in their lower and more receding foreheads, and in their shorter stature.

That palæolithic man possessed considerable mechanical skill, is shown by the well-fashioned flint implements that have been found; and the striking outlines of animals and men incised by him on pieces of ivory and bone, as well as the clever carvings in similar material, is evidence of no little artistic ability. And further, if we bear in mind how little of his work has been preserved to us, and how much that was perishable must have entirely disappeared, we shall be inclined to credit our palæolithic ancestors with a somewhat higher social status than we have usually supposed them to have enjoyed.

ALCOHOL IN RELATION TO MICROBIAL DISEASES.

THE effect of alcohol on the artificial production of immunity in animals in regard to rabies, tetanus, and anthrax has been recently studied by Dr. Deléarde. It has been frequently observed that persons addicted to alcohol suffer, as a rule, far more severely from the effects of microbial infections than normal individuals, and not long ago, in 1896, Abbot, of Philadelphia, showed that pathogenic bacteria, incapable of killing healthy animals, were able to produce fatal results in animals intoxicated with alcohol. This was found to be the case with the *B. coli communis*, the *staphylococcus*, and the *streptococcus*. Deléarde has turned his attention to the effect produced by alcohol on the artificial prevention of disease in animals; and, considering the great importance of the subject, it is to be regretted that his conclusions are drawn from so few experiments. It appears that a rabbit vaccinated against rabies, and then given considerable quantities of alcohol (introduced into the œsophagus by means of a tube) for several weeks, and subsequently inoculated with fresh rabid virus, did not succumb to rabies, whilst another rabbit treated similarly, only omitting the doses of alcohol, died of rabies. In this case the alcohol had apparently preserved the animal's immunity to rabies. On the other hand, a rabbit dosed with alcohol during the course of the anti-rabic inoculation, obtained absolutely no immunity from rabies; whilst a rabbit, first of all intoxicated and then vaccinated, acquired immunity to rabies as long as the supply of alcohol was stopped as soon as the vaccinations were commenced. In the case of tetanus, however, if the anti-tetanic inoculations were succeeded by the administration of alcohol, the animal lost all its artificially acquired immunity to the disease, and invariably succumbed to tetanus infection; again, if treated with alcohol during the vaccinations, it only acquired immunity to tetanus with difficulty, and if first of all intoxicated and then vaccinated, the animal obtained immunity as long as the supply of alcohol ceased when the vaccinations began. As regards anthrax, it is almost impossible, it appears, to protect animals from this disease if they are treated with alcohol during the vaccination period. On the other hand, animals first intoxicated and then vaccinated can acquire immunity providing, as in the other cases mentioned above, the alcohol is stopped as soon as the vaccinations are commenced, but they suffer considerably more during the process than animals which have received no alcohol. The experimental results obtained with rabies bear out the observations which have been made with regard to intemperate persons and the anti-rabic treatment in various Pasteur Institutes, and a very striking instance of the ineffectuality of the treatment in such a case was recorded only this year. An habitual drunkard was bitten by a mad dog, as was also a child by the same dog; both underwent precisely the same anti-rabic treatment. The man during the whole time continued to drink to excess, and subsequently died of rabies, whilst the child remained perfectly well. In the case of the administration of antitoxins it would appear, therefore, highly desirable that at least during the vaccinations alcohol should be prohibited.

STRIDULATION IN SOME AFRICAN SPIDERS.[1]

THE spiders which form the subject-matter of this paper, are probably best known by the comprehensive title "Mygale." They are also sometimes called crab-spiders, presumably from the great size to which most of the species attain; sometimes bird-eating spiders, from their alleged propensity for capturing and devouring small birds, a propensity which suggested to Lamarck the generic term *Avicularia*, still in use for one of the South American genera. But during the last fifty years our knowledge of this group has increased by leaps and bounds; the genus has expanded into a family, represented by numbers of genera which are rapidly becoming more and more accurately defined and classified.

Apart from their large size and usually heavy build, these spiders, referred to a family variously termed *Mygalidæ*, *Theraphosidæ* and *Aviculariidæ*, may be recognised from the vast majority of other spiders by possessing two pairs of lung-sacs, and by the circumstance that the mandibles or jaws project horizontally forwards; while the fang closes almost longitudinally backwards.

So far as habits are concerned, it may be added that none of the species spread nets for the capture of prey. Most of them live on the ground beneath stones, or in deep burrows which they excavate in the soil, and line with a layer of tough silk to prevent the infall of loose particles of earth or sand. At nightfall the spiders may be seen watching at the entrance of their burrows for passing insects, and during the breeding season the females are to be found at its further extremity mounting guard over their egg-cocoon. Other species again live in trees, and spin a silken domicile either between forked branches or in the hollow trunk, or in large leaves rolled up for the purpose. There is no doubt that their food consists almost wholly of insects of various kinds. Nevertheless cases are on record of the destruction of small reptiles, mammals, and birds by these monstrous spiders.

The discovery of stridulatory organs in the members of this family dates back to the year 1876, when Prof. Wood-Mason came across one in an Assamese species now known as *Musagetes stridulans*. Since that year organs like that which he described have been found, not merely in the solitary species as he and most of his successors appear to have thought would be the case, but in a great number of genera ranging from India to Queensland.

In some of the African *Theraphosidæ* Mr. Pocock has had the good fortune to discover two stridulating organs, which are not only quite different from each other, but also quite different from those possessed by the genera inhabiting Tropical Asia. One of these organs occurs in the genus *Harpactira*, the common "Mygale" of Cape Colony. It occupies the same position as the analogous organs existing in the Oriental species, being situated between the mandible and the maxilla. The other, on the contrary, found in *Phoneyusa* and its allies, is placed between the maxilla and the basal segment of the first leg.

What is to be said respecting the function of these organs, and what evidence, it may be asked, can be adduced in support of the view that they subserve stridulation? To this question the answer must be that so far as the African species are concerned there is no direct evidence based upon observation of the living animal to show what part they play in the spider's economy. But that their true and probably sole function is the emission of sound, is so strongly supported as to reach practical certainty from what is known of the function of the analogous organ detected by Wood-Mason in the Assamese genus *Musagetes*.

Observations have shown that the function of the instrument in spiders of this genus is to emit sound, so it may be concluded that organs constructed upon the same principle, and occupying the same or similar positions, will in all probability be found to perform the same office; and no further basis need be sought for the belief that the African spiders, *Harpactira* and *Phoneyusa*. and their allies, can stridulate as well as their Oriental relations.

What now is the use to the spider of the sounds that these organs give forth? It has been suggested that, like the call of the cicada and the chirrup of the cricket, they have a sexual significance, and serve to inform one sex of the whereabouts of the other. This belief, however, has no foundation in fact; for, in the first place, there is not a particle of evidence that these spiders possess an auditory sense; and, in the second place, these stridulatory organs are equally well developed in the males and females, and are not, like the sexual stridulating organs known in other groups, confined to the male, or at all events better developed in that sex than in the female. Moreover, they appear in the young at an early age, and become functionally perfected long before the attainment of sexual maturity. So the supposition that they act as a sexual signal may be regarded as unsupported by evidence.

As a matter of fact, the true key to their function is supplied by the behaviour of the living spiders. From observations by Mr. Peal and Mr. E. W. Pickard-Cambridge, it appears that the spiders emit the sound when on their defence and acting under the stimulus of fear or anger, in exactly the same way as the rattlesnake makes use of its rattle. Mr. Pocock points out that the only explanation that has been suggested touching the function of the snake's rattle is that it serves as an advertisement of the whereabouts of the poisonous reptile, so that it may be avoided by enemies which might otherwise inadvertently injure it. Similarly poisonous and noxious insects are decked with warning colours, so that they may be readily recognised and not slain in mistake for harmless or edible species. If this be the true explanation of the so-called warning coloration of the insects in question, and of the whirring noise made by the rattlesnake, there seems to be no reason to doubt that the same significance is to be attached to the stridulation emitted by the peculiar organs recently discovered in the great African spiders.

[1] Abridged from an article by Mr. R. I. Pocock in the *Zoologist*, January 15.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Professor of Mineralogy has been granted the sum of 50*l.* a year for five years, from January 1, to assist in the purchase of specimens and apparatus for his department.

Sir Archibald Geikie, F.R.S., will deliver the Romanes Lecture at the Sheldonian Theatre on Wednesday, June 1. His subject will be "Types of Scenery, and their Influence on Literature."

The Junior Scientific Club held its first meeting for this term on Wednesday, February 2. Mr. A. W. Brown exhibited and described some life specimens of *Aphrodite* and two specimens of the unsegmented Cestode, *Amphilina*. Mr. G. W. S. Farmer read a paper on "Training." Mr. A. E. Boycott (Oriel) is President this term.

CAMBRIDGE.—The Special Board for Biology have re-elected Dr. Arthur Willey to the Balfour Studentship for one year. The same Board have nominated Mr. K. R. Menon to occupy the University's table at the Naples Zoological Station.

Mr. W. W. Skeat, District Magistrate of Larut, Perak, has offered to the Ethnological Museum a collection of exceptional interest and scope, illustrative of the fast-disappearing indigenous crafts of Selangor and its neighbourhood.

Dr. G. Elliot Smith, advanced student of St. John's College, has been approved for the Certificate of Research. His original dissertations relate to the origin of the Corpus Callosum and to cerebral anatomy.

Mr. H. E. Durham, M.A., M.B., has been appointed one of the representatives of the University at the Madrid Congress of Hygiene, to be held in April next.

Sir E. Frankland has been appointed an Elector to the chair of Chemistry, Sir W. Turner an Elector to the chair of Anatomy, Prof. D. Oliver to the chair of Botany, Sir A. Geikie to the Woodwardian Professorship, Dr. Hugo Müller to the Jacksonian Professorship, Mr. L. Fletcher to the chair of Mineralogy, Lord Walsingham to the chair of Zoology, Lord Kelvin to the Cavendish Professorship, Sir W. H. White to the chair of Mechanism, Prof. Schäfer to the chair of Physiology, Lord Lister to the chair of Surgery, and Dr. J. F. Payne to the chair of Pathology.

IN the last paragraph of the Speech from the Throne, read at the opening of the new Session of Parliament, on Tuesday, it was announced that measures for the constitution of a teaching University for London, and for dealing in part with the subject of secondary education, would be brought forward "in case the time at your disposal should permit you to proceed with them." As several other measures are in the same case, the outlook is not

very hopeful for either of the educational measures referred to, and unless the Government seriously pushes them forward another Session will pass without the much-needed legislation. The measures are urgently pressing for consideration, and they ought not to be permitted again to lapse, as they have done before.

The *Lancet* announces that the Senate of Glasgow University have appointed Prof. Michael Foster to be Gifford Lecturer in the Glasgow University for the sessions 1898-99 and 1899-1900, in succession to Prof. Bruce, whose term of office expires with the current session.

The students of Finsbury Technical College will hold their annual conversazione at the College on February 18. Prof. S. P. Thompson has promised to lecture on "Wireless Telegraphy." Mr. Ives will give an exhibition of colour photography, and glow-lamp making will be demonstrated by Mr. Robertson.

An illustrated article on technical education in the United States, together with some other statistics relating to the occupations of students who have passed through certain representative American institutions, appears in the January *Record of Technical and Secondary Education.* Among other articles we notice one on technical instruction given to fishermen in Aberdeenshire and Essex.

The following item of information from the tenth annual report (1897) of the Clerkenwell Public Library, London, is worth recording:—"Scientific works are very largely circulated. Biology, including evolution and methods of scientific research, is a very popular subject, the sixty-eight works which the library contains on this topic having been issued over 2800 times within recent years. In this subject two copies of Darwin's 'Descent of Man' have been issued nearly 200 times, a record which is exceeded only by the most popular novels."

Dr. W. B. Benham, M.A., New College, Oxford, has been elected to the chair of Biology in the University of Otago, and will leave England at the end of March. Dr. Benham has for the past seven years held the post of "Aldrichian Demonstrator in Comparative Anatomy" at Oxford, and as such has acted as assistant to Prof. Lankester, to whom he was previously assistant in University College, London. For ten years Dr. Benham has been Lecturer in Animal Biology at Bedford College for Women, London; and was appointed Examiner in Zoology in the University of London last year. His original researches are embodied in some thirty papers: these are mainly concerned with the anatomy and classification of the Oligochæte Annelids; he has also contributed the article "Polychæta" to the Cambridge Natural History, and published an account of the Brain of the Chimpanzee "Sally," the Blood of *Magelina*, the Anatomy of *Phoronis*, &c.

At the annual congress of the South-eastern Union of Scientific Societies, held at Tunbridge Wells last May, Mr. S. Atwood, of New Brompton Natural History Society, drew attention to the difficulty of securing rooms for meetings in some of the smaller towns, even where suitable rooms belonging to Technical Institutes existed, which the Societies would be willing to hire. On the proposition of Mr. Pankhurst, of Brighton, the following resolution was passed unanimously:—"That it be an instruction to the Council of this Union to consider the question of how far buildings erected under or used for the purposes of the Technical Institution Acts may be made available for the use of local scientific societies." Since then the Council have had the matter under consideration, and have communicated with Colonel Holland, of the Kent County Council, who has replied to the effect that the Technical Education Committee have no control over Technical Institutes, and the local authority must be applied to for the permission desired. Colonel Holland adds: "If that authority wishes to help, it can do so without any permission from the Technical Education Committee." It appears, therefore, that no legal obstacle exists to the use of rooms belonging to or used for the purposes of technical instruction when such rooms are not needed for their special objects.

In a paper on the teaching of science in secondary schools, read on January 12, in Birmingham, before the Friends Guild of Teachers, Dr. Bevan Lean deprecated children beginning systematic work in science or entering the laboratory before the age of thirteen or fourteen, and urged that before boys (and girls) were allowed to learn chemistry or physics they should possess at least a sound knowledge of arithmetic. It was emphasised that the teaching of science in schools should not be in any sense commercial, nor should its aim be the mere awakening of interest or even the gain of knowledge: it was valuable solely as a means of mental culture, because through it could best be stimulated the power of accurately ascertaining facts and drawing correct inferences. It was urged that this educational value could best be obtained through chemistry, because chemistry admitted of quantitative experiment within the time of a short class and of an infinite variety of experiment; and, moreover, it so frequently touched matters and operations that were familiar to children in every-day life. The scientific method of investigating nature must be illustrated, and that necessitated placing the children in the attitude of discoverers, so that they could proceed from the known to the unknown, and not from the simple to the complex. Experience showed, too, that the problems on which great investigators were engaged 100 years ago were suitable for the modern schoolboy. This did not mean that we could build up the whole of our science for ourselves. The time for books and lectures would come, but at school it was far more important that boys and girls should be placed in direct contact with facts in the attitude of inquirers. It was a necessary corollary that the teacher ought to have a knowledge of the history of his science, and that it would be a great advantage if he had himself carried on original research: at the least, he ought to have an inveterate habit of inquiry.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, January.—On the commutator groups, by Dr. G. A. Miller. This is a collection of eleven theorems, some of which are proved in the present paper. For proofs of the remaining theorems reference is made to the writings of Frobenius and Dedekind. Dr. G. A. Miller has also a paper, read before the Society at its December meeting, entitled "On the limit of transitivity of the multiply transitive substitution groups that do not contain the alternating group." This is a paper which contains three theorems and four lemmas bearing upon results recently given by Jordan and Bochert in *Liouville's Journal* and the *Mathematische Annalen* respectively.—Geometry of some differential expressions in hexaspherical coordinates, by Dr. V. Snyder, read at the Toronto meeting; is an appendix to the author's dissertation "Ueber die linearen Complexe der Lie'schen Kugelgeometrie" (Göttingen, 1895). It gives an outline of differential geometry, and shows the application of it to the quadratic complex. Some results are, among the ∞^3 spheres which touch a given surface, there are ∞^2 which also cut a fixed sphere at a constant angle. These spheres either envelope another surface or are arranged in ∞^1 pencils, touching the surface along the curve of intersection with the sphere, which is then a line of curvature of the given surface (*cf.* Darboux, "Théorie des surfaces," vol. i. p. 257, who does not mention the exceptional case). The locus of the point-sphere in a spherical complex of degree n is a surface of degree $2n$, and contains the circle at infinity as an n-fold line. The surface of singularities of a quadratic spherical complex is a cyclide. The Dupin cyclide is the only surface that can be the complete envelope of a non-reducible special quadratic spherical complex. Numerous references are given to writers on the subject.—Dr. E. O. Lovett gives a useful abstract of some lectures by Sophus Lie, viz. "Vorlesungen über Differentialgleichungen mit bekannten infinitesimalen Transformationen" (edited by Dr. G. Scheffers, Leipsic, 1891).—Dr. Charlotte A. Scott, in a short note, commends a translation of Prof. Klein's "Vorträge über ausgewählte Fragen der Elementargeometrie," by Messrs. W. W. Beman and D. E. Smith.—The "Notes" and "New Publications" give their usual useful information.

Bulletins of the St. Petersburg Society of Naturalists, 1897 (xviii.), Nos. 2 and 3, February and March.—No. 2.—Geological excursion in North Russia, by Amalitzkiy.—Age of clay slates on the Upper Ulba, Altai, by von Petz.—Excursion to Crimea (botany), by Levandosvkiy.—On the part played by iron on the motions and the degeneration of cells when they are submitted to the bactericidal action of the immunised serum, by Sakharoff.—On fertilisation in *Juglans regia* and *J. nigra*, by Navashin.

No. 3.—On the relations between the Upper Tertiary in Russia, Rumania, and Austro-Hungary, by Andrusoff.—Journey to East Persia (geo-botany), by Korovyakoff.—All these communications are fully summed up in French or German.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 20.—"The Homogeneity of Helium." By William Ramsay, Ph.D., LL.D., Sc.D., F.R.S., and Morris W. Travers, B.Sc.

About a year ago, a paper by Dr. Norman Collie and one of the authors (W. R.) was published, bearing the title "The Homogeneity of Helium and of Argon." In that paper (NATURE, 1896, p. 546) various reasons were adduced to show why an attempt to determine whether or no argon and helium are homogeneous was worth making. The results of the experiments at that time indicated that while it did not appear possible to separate argon into two portions of different densities, the case was different with helium. Samples were obtained after repeated diffusion which possessed respectively diffusion rates corresponding to the densities 2·133 and 1·874. It was there pointed out that these densities are not correct (although their ratio is probably not wrong), owing to the curious fact that the rate of diffusion of helium is too rapid for its density, *i.e.* it does not follow Graham's law of the inverse square root of the densities. These samples of gas also differed in refractivity, and the difference was approximately proportional to the difference in density.

Towards the end of the paper, the conjecture was hazarded that it was not beyond the bounds of possibility that the systematic diffusion of what we are accustomed to regard as a homogeneous gas, for example, nitrogen, might conceivably sift light molecules from heavy molecules. It is true that the fineness of the lines of the spectrum would offer an argument in favour of the uniformity of molecular weight; but still it is never advisable to assume any physical theory without submitting it to rigorous proof. And it was thought possible that the fractional diffusion to which helium had been subjected might have had the result of effecting such a separation; a separation, not of chemical species, but of molecular magnitude. The other and more ordinary explanation of the splitting of helium into fractions of different density is that helium must be regarded as a mixture of two gases, one lighter than the other.

Since the publication of the paper mentioned, Dr. A. Hagenbach has confirmed the possibility of separating helium into portions of two densities by diffusion; and the differences in density were practically the same as those observed in the laboratory of University College, London.

These experiments were made with somewhat over 200 c.c. of gas; but it was decided to make experiments of a similar kind, on a much larger quantity of helium.

An apparatus was therefore constructed, similar in principle to the one previously employed, but on a much larger scale.

The Fractional Diffusion of Air.

In order to test the working of the apparatus, a set of diffusions was carried out with air. After four rounds, comprising twenty-four diffusions, the light portion contained 17·37 per cent. of oxygen and the heavy portion 22·03. A fairly rapid separation was thus being effected considering the closeness of the densities of nitrogen and oxygen.

The Fractional Diffusion of Nitrogen.

A similar set of experiments was carried out with nitrogen, prepared by the action of solutions of ammonium chloride on sodium nitrite, in presence of copper sulphate. The gas was dried and passed over red-hot iron prepared by reduction of ferric oxide in order to remove any oxygen or to decompose any oxides of nitrogen which might be present. After thirty rounds, involving 180 operations, the "light" portion of the nitrogen, after purification by circulation over copper oxide, had not altered in density. It must therefore be concluded that nitrogen is homogeneous as regards the relative density of its individual molecules.

The Fractional Diffusion of Helium.

The first sample of helium employed was prepared from samarskite and clèveite. After seventeen rounds, involving 102 operations, the diffusion rates of the lighter and heavier portions were measured.

A fresh quantity of gas from clèveite was similarly treated.

The light gas from the first set of diffusions was then mixed with the light gas from the second set of diffusions and the mixture was re-diffused fifteen times, involving ninety operations. The density of the lightest portion of this helium was determined by weighing and found to be 1·988. The helium had, therefore, not been made sensibly lighter by re-diffusion. The mean of the two determinations may be taken as the true density of pure helium; it is 1·98. The refractivity of this sample measured against hydrogen and multiplied by the ratio between hydrogen and air, viz. 0·4564, gives 0·1238. This specimen of light helium of density 1·988 was placed in one of the refractivity tubes, and the lightest helium of the former preparation (density = 1·979) in the other. They had the same refractivity (1000 to 1004). The contents of No. 1, obtained from the mixture of light gases, had the density 2·030, showing that only a little heavier material had been withdrawn.

The lighter fractions of helium were then sealed up in glass reservoirs and stored. The heavier portions were placed in the diffusion apparatus and submitted to methodical diffusion.

After fifteen rounds (ninety operations) the heaviest fraction had density 2·275, the lightest 2·08. The refractivity of the heaviest gas was next determined and found to be 0·1327. This gas examined in a Plücker's tube showed brilliantly pure helium lines, but along with these the reds and green groups of argon. Calculating from the density of this gas it should contain 1·63 per cent. of argon according to the equation $1·961x + 20y = 2·275$. Calculating from the refractivity the percentage of argon should be 1·05, from the equation $1·245x + 0·9596y = 13·33$. A mixture of 99 per cent. of the purest helium and 1 per cent. of argon was made, and it showed the argon spectrum with about the same or with somewhat less intensity than the heaviest gas. Finally, the heavy gas was diffused to the last dregs, so that only about 0·5 c.c. remained undiffused; and this small residue, transferred to a Plücker tube, showed the argon spectrum with only a trace of the spectrum of helium. The yellow line and the bright green line were visible, but feeble. This spectrum was compared with that of a mixture of argon with a trace of helium, and nearly the same appearance was to be seen. With the jar in parallel and a spark gap interposed the blue spectrum of argon was equally distinct in both tubes; and, more important still, *there was no trace of any unknown line*. It appears, therefore, that helium contains no unknown gas, nor is it possible to separate it by diffusion into any two kinds of gas; all that can be said is that most minerals which evolve helium on heating also evolve argon in small quantity. This accounts for the difference in density observed in different samples of helium; and in one instance, viz. malacone, the amount of argon evolved on heating the mineral, though small, was much in excess of the helium, so far as could be judged by the spectrum.

We are disappointed in the result of this long research, because we had thought it not improbable that an element of density 10 and atomic weight 20 might prove to be the cause of the fact that different samples of helium possess different densities, according to the mineral from which they are extracted, and also of the separation of helium into portions of different densities by diffusion. We still regard it as by no means improbable that further research will lead to the discovery of the "missing" element.

Addendum.—Since this paper was written, Profs. Runge and Paschen, in a communication to the British Association in August of last year, have withdrawn their contention that helium is a mixture, or, perhaps more correctly stated, they now ascribe to helium the same complexity as that of oxygen, the spectrum of which may also be arranged in two series, each consisting of three sets of lines. As oxygen has not yet proved to be complex, the surmise that helium is complex therefore falls to the ground.

Chemical Society, January 20.—Prof. Dewar, President, in the chair.—A ballot for the election of Foreign Members was held and Profs. S. Arrhenius, P. Curtius, A. P. N. Franchimont, W. Körner, W. Markownikoff, N. A. Menschutkin, H. Moissan, W. Ostwald, F. M. Raoult, I. Remsen, W. Spring, L. J. Troost, P. Waage and J. D. van der Waals were subsequently declared duly elected.—The following papers were read:—The preparation of pure iodine, by B. Lean and W. H. Whatmough. Pure iodine is conveniently prepared by heating cuprous iodide in a stream of dry air at 220–240°; it melts at 112·5–114°.—Derivatives of bromtolylhydrazine, by J. T. Hewitt and F. G. Pope.—Researches on the terpenes. (1) On the oxidation of fenchene, by J. A. Gardner and G. B. Cockburn. On oxidising fenchene with dilute nitric acid, cis-camphopyric acid and its anhydride are formed. Turpentine hydrochloride, when oxidised with nitric acid, yields camphoric and camphopyric acids.—The action of alkalis on amides, by J. B. Cohen and C. E. Brittain. The authors have succeeded in pre-

paring a series of compounds, which probably have the constitution $NNaR.C.Me(OH)_2$, by the action of caustic alkalis on amides.—The formation of monomethylaniline from dimethylaniline, by J. B. Cohen and H. T. Calvert. Phenylnitrocarbinol acts violently upon dimethylaniline with formation of nitrosomethylaniline, benzylic alcohol and benzaldehyde and evolution of nitrogen.—Note on the aluminium-mercury couple, by J. B. Cohen and H. T. Calvert. A small quantity of chlorine is retained by aluminium, probably as oxychloride, when it is amalgamated with mercuric chloride.—Action of chloroform and alkaline hydroxides on the nitrobenzoic acids, by W. J. Elliott.

Geological Society, January 19.—Dr. Henry Hicks, F.R.S., President, in the chair.—On some gravels of the Bagshot district, by Horace W. Monckton. The author referred to his papers on gravels south of the Thames, published in the *Quart. Journ. Geol. Soc.* for 1892 (p. 29) and 1893 (p. 308), and gave some additional details. He suggested that the occurrence of stones which had been very little rolled or waterworn in gravels at certain localities, afforded evidence of the presence of ice in the water by which those gravels were deposited; and that the position of some sarsens which he described was due to the same agency. He gave details and exhibited photographs of a number of sarsens which he had seen *in situ*. In the discussion which followed the reading of the paper, the hypothesis advanced by the author was criticised unfavourably by several speakers, but others supported it.—On the occurrence of chloritoid in Kincardineshire, by George Barrow. The rock containing the chloritoid was first found *in situ* at the entrance to the little gully at the head of Friar Glen Burn, near Drumtochty Castle. It has since been observed at many places along a belt of country extending from the coast north of Stonehaven nearly as far as the North Esk. The rock is easily recognised by the presence of numerous white spots, which are always present and are larger than the chloritoid. The chloritoid and the spots vary in size, being largest when the rock is most crystalline (a schist), and smallest when it is least crystalline (a slate). The mineral appears as minute glistening scales in the schist, but in the slate it can be recognised only with the aid of the microscope. The optical characters were described, and shown to be identical with those of the mineral from the Ile de Groix, and with those of the ottrelite from Ottré and Serpont. An account of the methods adopted to obtain a pure sample was given. Several analyses were made, and it was proved that as the purification increased, the analyses approximated more and more closely to the analysis of the mineral from the Isle de Groix. The final result was as follows:—SiO_2 26·00, Al_2O_3 40·05, FeO 19 50, Fe_2O_3 5·05, MgO 2·88, loss on ignition 6·00; total, 99·48.—The annual general meeting of the Society will be held on Friday, February 18, at 3 p.m.

Linnean Society, January 20.—Dr. St. George Mivart, F.R.S., Vice-President, in the chair.—Mr. J. E. Harting exhibited a series of photographs of the grey seal (*Halichærus grypus*) at various ages, taken from life by Mr. Henry Evans, of Jura, on the Haskeir Rock, Outer Hebrides, to which place the animal resorts every autumn for breeding purposes. Some of the photographs showed the young thickly clothed with white hair, which is retained for several weeks after birth, but is gradually shed before the animal enters the water. Details of measurement and weight were given, and occasion was taken to review the status of the grey seal as a British species, and to indicate its known breeding stations in the British Islands.—Mr. W. J. H. McCorquodale exhibited a skull of a hartebeeste which was one among some fifty skulls of various ruminants he had recently received, all having their horns infested by the larvæ of *Tinea vastella*, upon the chrysalids of which he offered some remarks. The collection was from Nigeria, and was made by his brother the late Lieut. R. H. McCorquodale, 3rd Dragoon Guards, while doing duty as a special service officer in W. Africa. He further recorded the capture by his brother, in 1896, of a giraffe from the regions of the Benue River, north of Calabar, remarking that the specimen was the only one known from this region of Africa, and that its skull was now deposited in our national collection.—Mr. W. E. de Winton, who was present as a visitor, made some remarks on the geographical distribution of the giraffe in Africa, and traced the limits of the range of the northern and southern species as far as had been ascertained.—Dr. W. G. Ridewood read a paper on the larval hyobranchial skeleton of the anurous batrachians, in which were recorded observations made on twenty-one species belonging to nineteen genera.—Mr. R. H. Burne read a paper on the *porus genitalis* of the *Myxinidæ*, in which he concluded that the urogenital sinus present in the lampreys is in the *Myxinidæ* unrepresented, and that the ureters and genital pore open into an integumentary cloaca.

PARIS.

Academy of Sciences, January 31.—M. Wolf in the chair.—Note accompanying the presentation of the notice on the scientific work of H. Fizeau, by M. A. Cornu.—On the approximate development of the disturbance function, by M. H. Poincaré.—On the meteorological observatories of the Atlantic Ocean, by S.A.S. Albert, Prince of Monaco. Two centres of observation, at San Miguel and Flores, have been established in the Azores, and the results are regularly telegraphed to certain continental observatories. The observations from these two stations gives some fifty hours' warning to European ports of approaching depressions.—Remarks by M. Mascart on the preceding paper.—M. Cremona was elected a Correspondent in the Section of Geometry in the place of the late M. Brioschi.—Martial function of the liver in the Vertebrates and Invertebrates, by M. Dastre. The hepatic organ whenever present is always distinguished from the other tissues by the increased amount of iron it contains. Thus in the Crustacea the liver is rich in iron, containing four times as much as muscle, the blood and ovary containing practically none. In Molluscs (cephalopods) the hepato-pancreas contains, weight for weight, twenty-five times as much iron as any of the other tissues; in Lamellibranchs the ratio is about five to one, and the same for Gasteropods. The presence of this iron is independent of the metal in the blood, thus where copper is present in the blood as hæmocyanine, iron only is present in the hepatic tissue.—Observations of the periodical comet of Arrest, made at the Observatory of Rio de Janeiro with the 25 c.m. equatorial, by M. L. Cruls.—On some photographs of nebulæ obtained at the Observatory of Meudon, by M. A. Rabourdin.—Remarks on the preceding communication, and on the correct method of getting comparable images of the nebulæ, by M. J. Janssen. A telescope was specially designed for this work, of 1 metre aperture and 3 metres focal length. Owing to its very short focal distance this instrument is very valuable for observing and photographing very faintly luminous objects, especially nebulæ.—On the development of analytical functions for real values of the variables, by M. Painlevé.—On the systems of partial differential equations, analogous to systems of equations of the first order, by M. Jules Beudon.—On the relations between the infinitesimal elements of two homographic or correlative figures, by M. A. Demoulin.—On surfaces applicable to a surface of revolution, by M. A. Pellet.—On the decomposition of Θ-functions into factors, by M. G. Humbert.—On the most general monographic method resulting from the relative position of two superposed planes, by M. Maurice d'Ocagne.—On the permanent changes of form and breaking of metals, by M. G. A. Faurie. Test pieces of metals, submitted to longitudinal stress under certain conditions, develop nodal points at equal distances apart. These effects are not produced by bending or torsion.—On the flexion of thick bars, by M. Ribière.—Experimental study of the lustre of projectors of light, by MM. A. Blondel and J. Rey.—Study of some radiations by interferential spectroscopy, by MM. A. Perot and Ch. Fabry. By means of the interference apparatus described in previous papers, it is now shown that the green thallium ray is composed of one bright ray and of two others, more faint, situated towards the red. The bright green ray of mercury is also triple, two of these three lines being separated by only $\frac{1}{150}$th of the interval between the sodium lines. Some of the cadmium lines were also split up.—On the measurement of high temperatures by the interference method, by M. Daniel Berthelot. The method is based upon the fact that if the density of a gas is diminished to the same extent on the one hand by a rise of temperature, or on the other by a diminution of pressure, the index of refraction has the same value in both cases. The constant temperature required in these experiments was obtained by means of an electric furnace, composed of two spirals of platinum wire, jacketed with asbestos, by which any temperature up to 1000° C. could be steadily maintained.—On the composition of air at different places, and on the density of gases, by M. A. Leduc. After discussing the errors inherent to the methods of Dumas and Regnault, figures are given for the composition by weight of air taken at various places and under varying conditions of wind. The author notes that in comparing the densities of various gases with oxygen the figures obtained by himself and Lord Rayleigh agree very exactly, but that compared with air

there is a constant difference of about ·0001, and hence concludes that the air of London contains 0·1 per cent. less oxygen than that of Paris.—New researches relating to the influence of the X-rays upon the explosive distance of the electric spark, by M. S. Guggenheimer.—On the Hertz resonator, by M. Albert Turpain.—On the decomposition of sulphite and hyposulphite of strontium by heat, and the production of phosphorescent strontium sulphide, by N. J. R. Mourelo.—Contribution to the study of oxydase in grapes. Its utility in the preparation of wine, by MM. A. Bouffard and L. Semichon. By the application of oxydase, white wines may be prepared from red grapes.—Phyllocyanic acid and the phyllocyanates, by M. A. Guillemare.—On the destructive action of a blood serum upon the red corpuscles of another species of animal. Inmunisation against this action, by MM. L. Camus and E. Gley.—Tyrosin, a chemical vaccine against snake poison, by M. C. Phisalix. This is the first known case where the cell sap of a plant confers immunising properties against snake poison.—The neurology of the encephalon in fishes, by M. Catois.—On the morphological limits of the rings of the integument, by M. Charles Janet.—On the fresh-water fauna of the Canary Isles, by M. Jules Richard. Among the species observed the following were the most remarkable: *D. similis*, var. *Alluadi*, and *Canthocamptus palustris.*—On the area of dispersion of the malacological fauna at great depths in the Atlantic, by M. Arnould Locard.—On the germination of the spores of the truffle, and the production of teleutospores, by M. A. de Gramont de Lesparre. The stages of germination are shown in nine diagrams.—On the age of the quaternary gravels of Villefranche (Rhône), by M. Gaillard.—On a new method for determining the position of foreign bodies by radiography, by M. H. Morize.

DIARY OF SOCIETIES.

THURSDAY, February 10.

Royal Society, at 4.30.—Contributions to the Theory of Alternating Currents: W. G. Rhodes.—The Development and Morphology of the Vascular System in Mammals. I. The Posterior End of the Aorta and the Iliac Arteries: Prof. A. H. Young and Dr. A. Robinson.—Further Observations upon the Comparative Chemistry of the Suprarenal Capsules: B. Moore and Swale Vincent.—The Effects of Extirpation of the Suprarenal Bodies of the Eel (*Anguilla anguilla*): Swale Vincent.

Mathematical Society, at 8.—The Transformations which leave the Length of Arcs on any Surface Unaltered: J. E. Campbell.—On Aurifeuillians: Lieut.-Colonel Cunningham, R.E.

Institution of Mechanical Engineers, at 7.30.—Report of the Council.—Discussion upon Mr. Philip Dawson's Paper on Mechanical Features of Electric Traction.

FRIDAY, February 11.

Royal Institution, at 9.—The Metals used by the Great Nations of Antiquity: Dr. J. H. Gladstone, F.R.S.

Royal Astronomical Society, at 3.—Annual General Meeting.

Physical Society, at 5.—Annual General Meeting.—Address by the President.—Also Paper: On Electromagnetic Induction in Plane, Cylindrical, and Spherical Current Sheets, and its Representation by Moving Trails of Images: Prof. G. H. Bryan, F.R.S.

Institution of Civil Engineers, at 8.—The Protection of Power Transmissions from Lightning: John T. Morris.

Institution of Mechanical Engineers, at 7.30.—First Report to the Gas-Engine Research Committee: Description of Apparatus and Methods, and Preliminary Results: Prof. Frederic W. Burstall.—Steam Laundry Machinery: Sidney Tebbutt.

Malacological Society, at 8.—Descriptions of Two New Species of *Clausilia* from the Province of Che-Kiang, China: E. R. Sykes.—List of the Species of *Cataulus* found in Ceylon, with Descriptions of some New Land Shells from that Island: E. R. Sykes.—Notes on the Genus *Coxiella*: E. A. Smith.—Note on *Cypræa caput-anguis*, Philippi, with the Description of a New Variety of *C. caput-serpentis*: Mrs. A. F. Kenyon.

MONDAY, February 14.

Society of Arts, at 8.—The Principles of Design in Form: Hugh Stannus.

Royal Geographical Society, at 8.30.—A Recent Journey in Western Australia: Hon. David W. Carnegie.

Imperial Institute, at 8.30.—Sierra Leone: Lieut. J. P. Mackesey, R.E.

TUESDAY, February 15.

Royal Institution, at 3.—The Simplest Living Things: Prof. E. Ray Lankester, F.R.S.

Zoological Society, at 8.30.—On the Osteology of the Steganopodes: W. P. Pycraft.—On the Skeleton of the Regenerated Limbs of the Midwife-Toad (*Alytes obstetricans*): Dr. W. G. Ridewood.—Description of a New Sea-Snake from Borneo: G. A. Boulenger, F.R.S.

Institution of Civil Engineers, at 8.—The Stability of Channels through Sandy Estuaries: P. M. Crosthwaite.

Royal Statistical Society, at 5.—Democratic Statistics of the United Kingdom: their Want of Correlation and other Defects: Edwin Cannan.

Royal Photographic Society, at 8.—Process Reproduction from an Editor's Point of View: Wallace L. Crowdy.

Royal Victoria Hall, at 8.30.—Brains: Hugh de Haviland.

WEDNESDAY, February 16.

Royal Meteorological Society, at 7.30.—Report on the Phenological Observations for 1897: Edward Mawley.—Monthly and Annual Rainfall in the British Empire, 1877 to 1896: John Hopkinson.

Royal Microscopical Society, at 8.—Essay on Micro-crystallography, with Lantern Illustrations: T. C. White.—Exhibition of Miscellaneous Lantern Slides: J. E. Barnard.

Entomological Society, at 8.—On the Genus *Erebia*: H. J. Elwes and Dr. T. A. Chapman.

THURSDAY February 17.

Royal Society, at 4.30.—*Probable Papers*: On the Depletion of the Endosperm of the *Hordeum vulgare* during Germination: H. T. Brown, F.R.S., and F. Escombe—On the Connection between the Electrical Properties and the Chemical Composition of Different Kinds of Glass: Prof. A. Gray, F.R.S., and Prof. J. J. Dobbie.—Contributions to the Mathematical Theory of Evolution. On the Inheritance of the Cephalic Index: Cicely Fawcett and Prof. K. Pearson, F.R.S.

Royal Institution, at 3.—Some Italian Pictures at the National Gallery: Dr. Jean Paul Richter.

Society of Arts (Imperial Institute), at 4.30.—The Plague in Bombay: Dr. Herbert Mills Birdwood.

Linnean Society, at 8.—On the Genus Arenaria: F. N. Williams.—On the Brain in the Edentata, including Chlamydophorus: Dr. Elliot Smith.

Chemical Society, at 8.—Some Lecture Experiments: J. Tudor Cundall.—Observations on the Influence of the Silent Discharge of Electricity on Atmospheric Air: W. A. Shenstone and W. T. Evans.

FRIDAY, February 18.

Royal Institution, at 9.—A Yorkshire Moor: Prof. L. C. Miall, F.R.S.

Epidemiological Society, at 8.30—The Relationship of Variations of the Ground-Water Level to the Incidence and Seasonal Distribution of Malarial Fevers in India: Surgeon-Captain Leonard Rogers.

SATURDAY, February 19.

Royal Institution, at 3.—The Structure of Instrumental Music (with Musical Illustrations): William H. Hadow.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Religio Medici: Sir T. Browne, edited by Dr. D. L. Roberts (Smith, Elder).—Chambers's Algebra for Schools: W. Thomson (Chambers).—A Flower-Hunter in Queensland and New Zealand: Mrs. Rowan (Murray).—Elementary Botany; P. Groom (Bell).—Quarterly Current Charts for the Pacific Ocean (Meteorological Office).—Elementary Physics: J. G. Kerr (Blackie).

Pamphlets.—Remarkable Comets: W. T. Lynn, 6th edition (Stanford). Quantitative Exercises for Beginners in Chemistry: A. H. Mitchell, 2 parts (Reading, National Publishing Association).—A Catalogue of Recent Cephalopoda, Supplement 1887–96: W. E. Hoyle (Edinburgh).—Mythos und Naturwissenschaft, &c.: G. W. A. Kahlbaum (Leipzig, Barth).—Eleventh Annual Report of the Liverpool Marine Biology Committee, &c. (Liverpool).

Serials.—Chambers's Journal, February (Chambers).—Natural Science, February (Dent).—Fortnightly Review, February (Chapman).—Scribner's Magazine, February (S. Low).—Journal of Botany, February (West).

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THURSDAY, FEBRUARY 17, 1898.

SIMPSON AND CHLOROFORM.

Sir James Young Simpson and Chloroform (1811–1870). By H. Laing Gordon. 8vo. Pp. xii + 233. (London: T. Fisher Unwin, 1897.)

THIS is the third volume of an important series entitled "Masters of Medicine," of which two volumes have already been issued under the editorship of the late Mr. Ernest Hart. The series is intended to contain the lives of men, both of this and other countries, who have done much to advance the science and art of medicine; and the introduction of chloroform is so intimately associated with the name of Sir James Simpson, that any series of the "Masters of Medicine" would be incomplete if it did not contain an account of one who was largely responsible for the general employment of this anæsthetic.

James Young Simpson was born in the year 1811 at Bathgate, a village in Linlithgowshire, where his father, David Simpson, was the local baker and farrier; he was the seventh son, and great things were foretold of him.

He attended the village school, and even as a boy, under the superintendence of his master at school, studied the archæological features of the neighbourhood, and this study he continued later when he attended Edinburgh University, where he was sent by the unselfish assistance of his brothers Alexander and John, who, after he was qualified, found the means to send him abroad.

At college his life was much influenced by his two friends MacArthur and Reid, who had, by their example and precept, much to do with his greatness in the future. In 1838 he became in Edinburgh an independent lecturer on midwifery; and in 1839, although only twenty-eight years of age, he applied for the professorship made vacant by the resignation of Prof. Hamilton. Finding his chance of obtaining the chair as a bachelor would be small, he went to Liverpool and returned with Miss Jennie Grindlay as his wife; and although the professors were opposed to his being appointed, he was elected by the Town Council with the narrow majority of one vote. As a professor he attracted not only the students of the college, but older men who came to hear the recently despised subject of midwifery dealt with in a masterly and scientific fashion.

The increased fame and, in consequence, the increased work attached, did not affect Simpson's homely life. He found time to take pleasure in the companionship of his friends and relatives. It was his custom to keep open house both at breakfast and luncheon time, but his evening meal was reserved that he might enjoy the intimacy of his own family.

It was in 1850 that Simpson took part in the great controversy on the merits of homœopathy, which he condemned as irrational, and it was through him to a great extent that homœopathy was thoroughly crushed in Edinburgh.

Prof. Simpson's versatility was remarkable. He was able to discuss any subject in literature, science, politics or theology; but it was in archæology that he did most work outside his profession. He had correspondents in different parts of Scotland engaged in making researches into antiquities, and in 1861 he became President of the Society of Antiquaries of Scotland.

It is, however, with chloroform that the name of Simpson will chiefly be associated. To many people chloroform is anæsthesia, and the previous introduction of ether is often ignored. It is, therefore, hardly superfluous to repeat that ether was introduced in 1842 by Mr. W. T. G. Morton, a dentist of Boston, Massachusetts; its use rapidly spread, and it was employed extensively in America, Great Britain and abroad. The administration of ether was not unattended with difficulties; the methods employed at that day would now be considered extremely crude, and many—both surgeons and chemists—were looking eagerly for a simple and more convenient anæsthetic; and Simpson, although at this time much occupied with his increasing practice, gave all his leisure to testing for himself the effects of numerous drugs. After innumerable failures he, together with Dr. George Keith and Dr. Matthew Duncan, on November 4, 1847 at last tried chloroform, which was suggested to them by Mr. Waldie, a chemist of Liverpool, but had been discovered and described in 1831 by Soubeiran and Liebig independently. We may quote here the account given of the first employment of chloroform as an anæsthetic:—

"Immediately an unwonted hilarity seized the party—they became bright-eyed, very happy, and very loquacious—expatiating on the delicious aroma of the new fluid. The conversation was of unusual intelligence and quite charmed the listeners—some ladies of the family and a naval officer, brother-in-law of Dr. Simpson. But suddenly there was a talk of sounds being heard like those of a cotton-mill louder and louder; a moment more and all was quiet—and then crash! On awakening Dr. Simpson's first perception was mental. 'This is far stronger and better than ether,' said he to himself. His second was to notice that he was prone on the floor, and that among his friends about him there was both confusion and alarm.

"Hearing a noise he turned round and saw Dr. Duncan beneath a chair—his jaw dropped, his eyes staring, his head bent half under him; quite unconscious, and snoring in a most determined and alarming manner. More noise still and much motion. And then his eyes overtook Dr. Keith's feet and legs making valorous efforts to overturn the supper table, or more probably to annihilate everything that was on it. By and by Dr. Simpson having regained his seat, Dr. Duncan having finished his uncomfortable and unrefreshing slumber, and Dr. Keith having come to an arrangement with the table and its contents, the sederunt was resumed."

It is Simpson, too, whom we have to thank for fighting those who found in the practice of anæsthesia something which was contrary to their beliefs or principles, and for making the giving of anæsthetics an every-day occurrence; and we can hardly at the present day imagine the little-mindedness displayed by those who endeavoured, fortunately without success, to oppose the employment of anæsthetics.

About ten years after the introduction of chloroform he turned his attention to wound healing; at this time bleeding was arrested by tying the cut arteries with ligatures, and the ends of these were left hanging out of

the wound. In 1858 Simpson stated that he had made use of iron, silver, and platinum wires, and after ten years' research he was led to the introduction of acupressure, which essentially consisted in the passing of a fine needle through the tissues across the course of an artery so that by pressure against the muscles the bleeding was stopped. He was much disappointed that acupressure had failed to gain a place such as he would have wished; but the introduction of the antiseptic method by Lister threw his process into the shade.

During the last year or two of his existence he found it hard to carry on his work, and he had to take more rest, but he still kept on his practice although suffering from angina pectoris. However, in February 1870 he was obliged to take to his bed, yet even then he saw patients in his sick room; later his failing strength prevented this, and he passed away on May 5, 1870.

Mr. Gordon has dealt with the facts at his disposal in an interesting manner; but as the book is one of a series connected with medicine, and as Simpson's chief claim to remembrance is associated with the introduction of chloroform, we are somewhat surprised to find that only about forty-four pages have been devoted to this portion of the subject.

We think, also, that more might have been made of Sir James Simpson's contributions to obstetrics, though no doubt the popular character of the series is responsible for the omission. R. T. B.

PROTOPLASMIC FROTH.

The Living Substance as such, and as Organism. By Gwendolen Foulke Andrews. Pp. 176. (Boston: Ginn and Co., 1897.)

THE authoress of this wordy treatise informs us (p. 173) that she started from a neutral position with regard to Bütschli's vesicular theory, or even with a bias against it. Now, however, having become the most ardent of converts, she proceeds, with the proverbial zeal of a proselyte, to carry the original doctrine to extremes. Not content with proclaiming the existence of foams undreamt of by Bütschli—"wheels within wheels" *ad infinitum*—she utters what amounts to a denunciation of all previous statements of biological fact and theory as misleading and inadequate, and urges in effect that the whole science of life needs recasting from the new point of view. So far, she is doubtless within her rights. There is nothing in the expression of even the most singular views which can legitimately form the subject of complaint. Time tries all things; and of the numerous hypotheses that are every year thrown out to take their chance in the world of scientific opinion, some will stand the test and will become the recognised truths of a later generation, while others are simply destined to die a natural death. But there is no excuse for presenting any theory in such a form as that of the present volume. The obscurity of the style, the inordinate length of the argument, the wearisome repetitions, the general want of method and arrangement, form an unfair tax on the patience of the reader, who may be excused if he fails to find the one half-pennyworth of bread to this intolerable deal of sack. The authoress should have given us, in an orderly manner, first the facts she has observed, and secondly such interpretations of them as she thought warranted. Instead of this she has produced a confused and intricate commentary on phenomena that for the most part are either not recorded at all, or are referred to in such a vague and general manner as to make it extremely difficult to judge of their import. It is true that she appeals from time to time to her "researches" and "results," without, however, proving much more than her ignorance of the meaning of those words. Here and there we find an observation of interest, as on pages 58 (chromatin in the cytoplasm), 70 (explanation of apparent Brownian movements), 116 (protoplasmic interchange in colonies of *Raphidiophrys*). But these are scattered and scanty, nor are they recorded with scientific precision. Moreover, the want of arrangement is such that the reader who wishes to refer a second time to any observation will be at a loss to find it. Here and there, also, some semblance of a definite conclusion seems about to emerge from the general chaos. But the expected result, when not of a trite and obvious character, usually proves elusive; and the reader who had hoped to grasp a new piece of knowledge finds himself put off with a handful of empty verbiage—

Ter frustra comprensa manus effugit imago.

If any object is discoverable, it is to show that from nature's point of view the living substance is everything and the individual organism nothing. The authoress does not seem to be aware that so far as this is true, it has occurred to previous thinkers. It is refreshing to come across a few words of common sense like the passage she quotes from Darwin on page 173. But we can assure her that the theory of natural selection not yet being dead, its "re-birth" under her auspices is at present a superfluity. On page 52 she defends her practice of saying the same thing over and over again on the ground that nature herself indulges in repetition. This is true; but nature does many other things that need not be imitated in a scientific memoir. The authoress would do well to supplement her studies from nature by taking a hint from art, especially in the way of compression. "Very few and very weary," said Macaulay of a book which had more excuse for prolixity, "are those who are in at the death of the 'Blatant Beast.'" The authoress would seem (p. 175) to be conscious that her own work may be open to the like criticism; it is a pity that she has not thought it worth while to aim at a different result.

The temptation to pass over the whole book in silence is a strong one. We have not yielded to the temptation, because we think that the authoress is capable of better things. She is apparently possessed of means, leisure, perseverance and enthusiasm—no bad equipment for a scientific career. Let her continue to observe patiently, but let her record with precision. Let her avoid cheap disparagement of the microtome and paraffin bath; they are bad masters, but may be good servants. Let her not think that she can overcome the inadequacy of figures and diagrams by abjuring their employment altogether. Let her condescend to the use of the English language

as it is written by ordinary people. Above all, let her seek the advice of some leading man of science in whom she has confidence, and get him to revise her work before publication—submitting, if necessary, to a severe editing of her "results." We trust that she will take in good part what we have thought it our duty to say, for we feel convinced that if she will but consent to put a check on some of her impulses and to proceed on lines that have stood the test of time and experience, the new work with which she threatens us may yet prove to be a real and valuable contribution to the literature of protoplasm. F. A. D.

CATALOGUE OF MADREPORARIA.

Catalogue of the Madreporarian Corals in the British Museum (Natural History). Volume iii. The Genus Montipora, the Genus Anacropora. By Henry M. Bernard, M.A. Large 4to. Pp. vii + 192. Plates xxxiv. (London: Printed by the order of the Trustees, 1897.)

OF the two genera, Montipora and Anacropora, catalogued in this volume, the latter is stated by the author to be little more than a group of specialised Montipores, so that the contents of the book may be said to relate nearly entirely to the single genus Montipora, Quoy and Gaimard. This genus is one of the reef-building, perforate corals, included with Madrepora, Turbinaria and Astræopora in the family of the Madreporidæ. It is widely distributed in the Indo-Pacific region wherever coral reefs occur, and the Museum collections of it have been largely added to of late years, by specimens obtained by Mr. Bassett-Smith, Surgeon R.N., from reefs in the China Sea, by Mr. Saville-Kent from the great Barrier Reef of Australia, by Prof. Haddon from Torres Straits, and by Mr. Stanley Gardiner from Funafuti.

The distinguishing structural feature of Montipora, as compared with the other members of the Madreporidæ, is the great development of the porous cœnenchyma between the corallites, and the comparatively reduced size and inconspicuous position of these latter. The upper surface of the cœnenchyma in these corals is furnished with an extraordinary variety of minute papillæ, tubercles, and ridges, which appear to be very liable to change, so that even in the same specimen the differences may be sufficient to constitute four or five distinct types. In spite of this fact, the author has based his systematic classification of the species mainly on the characters of this defensive surface ornamentation of the cœnenchyma, and justifies his course on the plea that there is no other available alternative. The result is that each individual specimen, and almost every fragment may, without much difficulty, be regarded as a distinct species, and in practice this is approximately the case. Thus of the eighty-eight new species constituted by the author, fifty-four are founded on single specimens or stocks, and in fourteen others, there are, in the Museum collection, but two specimens or fragments to each species. The remaining twenty new species are represented by three or more specimens each, but it is evident, with regard to most of these, that the puzzled mind of the author has led him temporarily to a wholesale lumping of the specimens. These specimens or reputed species are described with great care and detail, but that they will be accepted as valid species seems very doubtful.

The volume is illustrated by thirty collotype plates, showing the corals either of their natural size or reduced to one-half or two-thirds, and by four lithographed plates of the surface characters enlarged. Many of the collotype figures, owing to their reduced scale, are of comparatively slight value, but the enlarged figures are very carefully drawn, and should prove highly useful for comparison; they would have been of still more service if drawn on a more uniform scale, instead of, as now, ranging between six and forty diameters. We regret to note that eighteen of the *new* species in this volume are not accompanied by any figures, and of several others no enlarged surface drawings are given; it is surprising that such a deviation from the established scientific procedure of figuring new forms should be permitted in a work issued by our leading scientific institution. It would, further, have been desirable to show by figures the "middle streaming layer" and the lower and upper layers of the cœnenchyma with their bent threads, since this terminology appears to be new.

We venture to remark that the numbers of the specimens in the Museum Register are only quoted here and there in this volume of the Catalogue, whereas in the first volume they are scrupulously given in all cases. Any one who has had to hunt up a type specimen in the Museum, will acknowledge the advantage of being able to quote the "registered number," and it is very important where, as in the case of these corals, nearly every specimen is a type (and perhaps unfigured), that the registered number should be given in the published Catalogue, so as to be available for identification.

The maze of variations shown in a collection of recent corals call for the utmost patience, courage and judgment on the part of the investigator, and Mr. Bernard deserves the greatest sympathy and encouragement in the difficult and puzzling task which he has undertaken.

G. J. H.

OUR BOOK SHELF.

Das Wachstum des Menschen. By Dr. F. Daffnfr. Pp. vi + 129. (Leipzig: Engelmann, 1897.)

IN one hundred and thirty pages the author traces the physical development of man from the embryological state through that of fœtal existence to childhood, and thence to puberty, maturity, and decay.

The first few chapters are devoted to the proportions and weights of fœtuses of various ages, along with the causes which determine the sex of offspring. The view adopted is that the more vigorous element prevails, the argument being based upon the fact that young primiparæ (seventeen to nineteen years) bear a large percentage of boys; while women in full vigour (twenty to twenty-one years) bring forth more girls, the percentage of the latter decreasing again as the age of the mother increases.

Puberty, with its accompanying physical changes, together with a severe condemnation of the corset and

modern views on beauty of the female form, occupy the next section.

The average weight of the new-born infant, the greater decrease in weight during the first few days of the male than the female, and of the first-born than the children of multiparæ, along with the subsequent daily increase, is given accurately and in an interesting and comprehensible style.

Although adopting weight *faute de mieux* as a method of comparing brains, the fact that the intellectual qualities of that organ do not vary directly with its mass is recognised, and illustrated by reference to individual cases. Unfortunately, when comparing the results of various observers, no statement is made as to which, if any, membranes are included with the nervous substance.

The book, admirably adapted for students acquainted with anthropometric methods, comprising many original observations, deals mainly with measurements and weights. The absence of instruction as to how they are obtained, detracts from its value to beginners; while the pathological and anatomical details scarcely recommend it for popular instruction.

Beschreibung der Hauptmethoden, welche bei der Bestimmung der Verbrennungswärme üblich sind. By W. Longuinine. Pp. 112, with 4 copper-plates and 21 figures. (Berlin: R. Friedländer und Sohn, 1897.)

THIS excellent work had already been printed in Russian when Berthelot's "Traité pratique de Calorimétrie chimique" appeared. The German translation may, however, be welcomed, because its scope differs considerably from that of Berthelot's book. The estimation of heat of combustion is alone dealt with by Longuinine, the rest of thermo-chemistry being left untouched. One of the results of discussing only a part of a subject is that, as far as it goes, this book is remarkably complete. Besides a full description of the calorimetric bomb and the precautions to be observed in its use, an account is given of the older methods of estimating the heat of combustion, which are still used to some extent, owing to the high price of Berthelot's bomb. Under certain conditions, duly set forth in the text, these old methods give exact results. The illustrations are capital, though unfortunately not drawn to scale, and the whole volume is handsome. By some strange mischance, it is not furnished with either an index or a table of contents.

Cheltenham as a Holiday Resort. Part I. *The Neighbouring Hill-Country.* By S. S. Buckman, F.G.S. Pp. 100. (Cheltenham: Norman, Sawyer, and Co., 1897.)

THE geology and archæology of Cheltenham and the neighbourhood are described in this book in a way which will induce the reader to make further inquiries into the why and the wherefore of the interesting characteristics referred to. The book will add to the enjoyment of ramblers in the country around Cheltenham, and will be of special value to those who visit the district in search of scientific information. The author has himself made investigations of Cotteswold geology, and his book contains the results of original observations as well as references to the work of others.

Nature's Diary. Compiled by Francis H. Allen. Eight photogravures. (London: Gay and Bird).

ON the left-hand pages are literary extracts, chiefly from Thoreau; on the right, blank paper for the events of the natural year, with here and there a printed note. The naturalist who uses the book must give it all its value. He would do much better to buy a note-book and a copy of Thoreau's "Walden." This is a book for show and not for use. The eight photographs from nature are capital. L. C. M.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Protective- and Pseudo-Mimicry.

I HAVE just been reading the presidential address to the Entomological Society on the subject of mimicry, and one or two statements with regard to mimicry among the *Heterocera* seem to me to stand in need of correction. It is stated on the authority of Colonel Swinhoe that *Teracolus etrida* is accurately mimicked by the geometer *Abraxas etridoides*, and that this supports his contention that the species of *Teracolus* are protected.

I described *Abraxas etridoides* from a single specimen taken on the Palni Hills, South India, by M. Elwes, pointing out its resemblance to the *Teracolus*, which also occurs in South India. This was quite enough for such an ardent student of mimicry as Colonel Swinhoe to base the above statement on, without knowing any more of the species, and probably without ever having seen it, the type being in a private collection. I have, however, lately received more specimens, and been able to learn its habits from collectors on the Palnis, where it rests in damp woods during the day on the plateau, as is the habit of the genus, whilst the *Teracolus* does not occur on the hills, but flies in the hot sun of the plains 6000 feet below; the fact being that all the species of the genus *Abraxas* secrete acrid juices and are distasteful, whilst *Teracolus* is not protected.

Again, it is stated that Danaid butterflies are mimicked by three genera of the *Chalcosia* group of *Zygænidæ*. These again secrete strong acrid juices, as does the whole family to which they belong, and they are so distasteful that hardly any other animal will touch them; their habits, too, are extremely different from those of butterflies, and no one who knows them in life could possibly believe in protective mimicry between the two groups. The *Chalcosias* sit about on tree trunks, but are very easily disturbed, when they fly with an extremely wavering flight for a short distance and then settle again. The only exception in this habit known to me is the Papilio-shaped genus *Histia*, which flies high over forest trees backwards and forwards with wavering flight, resembling that of the Vapourer Moth in our London squares, and looking so unlike butterflies that not even the veriest tyro could mistake them, besides being about one-third the size of any *Papilio*. Both these cases, therefore, will, I think, have to be relegated to the rapidly swelling ranks of museum-made mimicry.

Protective mimicry entirely depends on community of habit, and it used to be considered that accurate field observations were necessary to establish it. Now that it has been degraded to the matching of specimens in a drawer like ribbons in a shop, being a nice easy subject to philosophise on and entailing a minimum of work, it has lost all claim to serious consideration.

February 8. G. F. HAMPSON.

Oat Smut as an Artist's Pigment.

THE deep brown or sepia-coloured spore dust often seen on cereals, and arising from the presence of a fungoid growth, is sufficiently rich in colour to become useful as a pigment for the artist. The colour obtained from smutty oats, for example, is of a deep rich umber shade, sometimes approaching to sepia in tone. Satisfactory experiments were made regarding its fastness to light and atmospheric influences. Specimens of the pigment painted on paper as a water-colour were exposed to direct sunlight for several months; and after this rather severe trial, they were compared with unexposed duplicate specimens. Little change in the appearance of the colours was apparent. With mild diffused daylight—such as that of an ordinary, well-illumined room—the colour remains quite fast and unaltered. Experiments were made on a small scale with oat smut pigment, and the results seemed highly satisfactory. Several grams of the dry spore dust were collected from smutty oats, and it was found that twelve heads of such oats yielded six grams of the brownish-black dust. This powder, being of a dry and light nature, had first to be moistened with a few drops of alcohol, then mixed with gum and water to form a water-colour pigment. In its deepest tones it is of a fine sepia shade, deepening to a brown-black. On diluting with water or Chinese

white, pleasing tints of a flat brown, of the pheasant-egg cast, are obtained. This colour has met with approval among artist friends to whom it was shown.

The beauty of colour and fastness to light of this pigment, from such an unpromising material, may be of interest to artists' colourmen. DAVID PATERSON.

Leabank, Rosslyn, Midlothian.

Early Spring Flowers.

YOUR readers will doubtless have been observing how the mildness of the weather this winter, so far, has hastened on the spring flowers. I am inclined to think that some of the dates mentioned below have not often been paralleled. The dates in brackets, of the usual flowering times, have been taken from Babington's "Manual of Botany" and Johnson's "Gardeners' Dictionary." December 10, 1897, *Helleborus fœtidus* (February); December 23, 1897, *Eranthis hyemalis* (February, March); December 31, 1897, *Iris histrio* (December to March); January 14, 1898, *Mercurialis perennis*, ♂ (April and May); January 14, *Corylus avellana*, ♂; January 29, ♀ (March, April); January 15, *Galanthus nivalis* (February); January 19, *Anemone hepatica* (March, April); January 20, *Anemone fulgens* (February 20, 1897), (March, April); January 20, *Ranunculus Ficaria* (February 20, 1897), (April, May); January 20, *Viola odorata*, wild (March, April); January 21, *Iris histrioides* (March); January 21, *Tussilago Farfara* (February 20, 1897), (March, April); January 21, *Berberis Aquifolium* (April); January 22, *Potentilla Fragariastrum* (April, May); January 24, *Primula vulgaris*, wild (March to May); January 24, *Crocus aureus* (February); January 26, *Omphalodes verna* (March); January 29, *Aucuba japonica*, ♂ (June). On the ♀ plant there is no sign of flower yet, and the berries have just turned red. January 29, *Ulmus surculosa* (February 21, 1897), (March to May); January 29, *Daphne Laureola* (February, March); January 29, *Arabis albida* (February 21, 1897), (February). Among other plants which began to flower in November, and have gone on until now with unusual luxuriance, we have noted *Garrya elliptica*, ♂ (just over), *Viburnum Tinus*, *Petasites fragrans*, *Lonicera fragrantissima*, *Ionopsidium acaule*, *Erica carnea*, garden violets, and primroses, single and double, and forget-me-not. I may add that on December 1, 1897, in the course of an hour, in and around the garden here, I noted upwards of 120 different kinds of plants in flower. A few were winter flowers, but most of them were belated summer and autumn ones.

Aphides are feeding on young rose and iris leaves, and slugs are playing havoc with young shoots of herbaceous and alpine plants.

A young rabbit was seen ten days ago in Devonshire, and in Gloucestershire a nest containing eggs of the blackbird and one of the robin with eggs were found about the same time.

Dadnor, Herefordshire, January 31. E. ARMITAGE.

Insusceptibility of Insects to Poisons.

IN your review of "Notes of a Naturalist and Antiquary" in the issue of November 18, it is said that the caterpillar of the Spurge Hawk Moth "feeds exclusively on the Sea Spurge, although the plant secretes an acrid juice 'so painfully poisonous that it is difficult to imagine a digestive apparatus competent to deal with it.'"

This recalls to me a case, which came under my notice some years ago, in which a druggist had prepared a quantity of poisoned wheat for killing sparrows, then lately introduced here and a great nuisance, by soaking it in a solution of strychnine coloured with magenta. He found that on keeping it for some time in cardboard boxes it became infested with weevils; so I examined it to find if it really contained the alkaloid. The boxes were full of weevils and their excrement, and the wheat was more than half of it eaten. Strychnine was present in the wheat in the weevils, and in apparently larger proportion in the excrement, so that it had evidently passed through the digestive apparatus unchanged. WILL. A. DIXON.

Sydney, December 31, 1897.

MR. DIXON's letter supplies a further illustration of the curious fact that certain insect larvæ are able to feed upon poisonous plants with impunity, and can pass through their digestive system an amount of poison sufficient to kill many a more highly organised being. It is perhaps owing to their being less highly organised that they are not susceptible to the poison. Although various instances in support of the fact have been placed on record, I have not met with any attempted explanation.

M. Félix Plateau, in a paper on the phenomena of digestion in insects, published in the *Mémoires de l'Académie Royale de Belgique* (tome xii.), an abstract of which may be found in the *Annals and Magazine of Natural History* (ser. 4, vol. xvi.), has remarked that some substances resist the digestive action and are passed with the excrement—as in the case of the weevils examined by Mr. Dixon. Such, he says, are the chitine of the integuments of insects, vegetable cellulose, and chlorophyll, which by the aid of the micro-spectroscope may be detected at all parts of the alimentary tube of herbivorous insects; but he says nothing of the effects of poison.

Dr. T. R. Fraser has shown (*Ann. and Mag. Nat. Hist.*, ser. 3, vol. xiii.), that the caterpillar of *Deiopeia pulchella* feeds on the virulent poison contained in the kernel of the seed of *Physostigma venenosum*, and is unaffected by the poisonous principle of the kernel—"eserinia." Yet he ascertained by experiment that the caterpillars subjected in various ways to the action of hydrocyanic acid quickly died, proving that this species possesses no universal panacea against all poisons.

Curious to relate, another insect, a weevil *Anthonomus druparum*, feeds with impunity on the very poison which is fatal to the last-mentioned insect, namely on the kernel of *Prunus cerasus*, the poisonous properties of which depend on the hydrocyanic acid it contains. It appears, therefore, that what is one insect's food is another insect's poison, and *vice versâ*. The subject offers a fine field for investigation, and the results of further experiments, if made known, would be of interest to many besides professed entomologists.

THE REVIEWER.

Variation of Water-Level under Wind-Pressure.

IN confirmation of Mr. Wheeler's observations as to the variation of water-level under wind-pressure, two interesting beaches in the Great West Bay may be cited.

At the Chesil Bank (where all forces combine to raise the water-level) a height of 42 feet 9 inches above normal spring tide, high-water, is the height of the shingle-barrier raised by winds, waves, and currents to bar their own progress. Within the same bay, in the minor inlet of Torbay, the beach at Goodrington Sands (exposed to an easterly drift of more than 200 miles, and to waves exceeding 300 feet from crest to crest) rises 5 feet above the mark of fine weather spring tides; and this low bank is, or was when I saw it in 1889, the sole barrier between a grass field and the English Channel. The explanation clearly is that the harder it blows from the east, the more the level of the English Channel is lowered and the waters of Torbay with it.

Torquay, February 4. A. R. HUNT.

Bipedal Lizards.

MY correspondent, Mr. H. Prestoe, has taken the trouble to examine the collections at the Natural History Museum, and by so doing has identified the bipedally-running Diamond Lizard of Trinidad, referred to in my last week's communication, with the *Ameiva surinamensis* of Gray. This identification is of additional interest, since it associates the faculty and habit of bipedal locomotion with yet a third family group of the lizard tribe, namely, that of the Teiidæ.

A good illustration of the species under notice, in a state of repose, is given in vol. v. of Lydekker's "Royal Natural History." W. SAVILLE-KENT.

THE TOTAL ECLIPSE OF THE SUN.

THE first Indian mail dispatched after the total eclipse of January 22 has now arrived, and it brings a number of details of the work done and results obtained during the two minutes of totality. It is therefore now possible to supplement the information derived from cablegrams already published in NATURE (January 27, p. 294) with extracts from the reports of the various eclipse parties. The Government of India appears to have rendered assistance to all the observers, and it has earned the gratitude of men of science

for the active interest shown in the whole of the astronomical operations. Rarely, if ever, has the work of observers been given greater facilities; and the credit for the success of the recent eclipse investigations is due, to a large extent, to the help of the Indian Government, as well as to the perfect weather which prevailed.

The invaluable aid given by the officers and crew of H.M.S. *Melpomene* was described by Sir Norman Lockyer in last week's NATURE. The results obtained by this new eclipse force appear to have exceeded the highest anticipations, and our only source of regret is that the trained perceptions of the officers and men of our ships have not previously been enlisted to advance the knowledge of solar physics by observations of solar eclipses. Naval officers are so familiar with optical instruments, that they need but a few hints to be able to make most of the observations required during eclipses. The "Melpomenes" have proved their efficiency as eclipse observers, and we hope their work will be taken as a model of what can be done upon future occasions by enlisting the sympathies of naval officers and men in astronomical investigations; for the knowledge thus obtained is both abundant and valuable. To the assistance given by Captain Batten, who took charge of all the affairs of administration and organisation, must be ascribed a large portion of the success at Viziadurg.

Sir Norman Lockyer expressed this opinion in the course of a few remarks made by him at the end of the eclipse.

"You have no right to cheer me," the *Times of India* reports him to have said, "but I have the right to cheer you, and had I a hundred and fifty throats I would do it right heartily. It is you, the officers and men of H.M.S. *Melpomene*, who have been running this camp, and we three have just stood by. You have done all the work, and you have been making a bit of history, not only for British science but for the British Navy. The records of this expedition will be logged in one of the Admiralty books, and I am proud to have been associated with you in this Eclipse Expedition of 1898. The work you have done has not only been in proportion to your numbers, a hundred and fifty to three, but you have borne the burden and heat of the day, and I thank you from the bottom of my heart for the admirable manner in which you have behaved towards we land-lubbers. We have done our best, you have done your best, and between us we have to-day accomplished what has never previously been done in the history of the world. A hundred and fifty British Bluejackets have observed an eclipse just as perfectly as if they had been drilled for years instead of a few days. We have been perfectly successful along all the lines of work we laid down, and we have done everything we tried to do. I do not really thank you a bit, but I congratulate you from the bottom of my heart upon the splendid success you have achieved."

From the various reports which have now reached this country, we make a few extracts to show what scientific results were obtained at the eclipse stations, beginning with extracts from the letter contributed by Sir Norman Lockyer to Tuesday's *Morning Post*.

VIZIADURG.

"When I come to the scientific results I hardly know how to begin, for there is so much to tell. The 'Melpomenes' have certainly beggared all former records. In the prismatic cameras every plate we hoped to expose at the different times, carefully thought out beforehand and bearing in mind the capacities of the two instruments, now bears a precious record. In the two cameras the number of spectra photographed amounts to about sixty; of these forty are distributed over four plates—'dropping plates,' as they have been called, because they drop inch by inch and second by second at the beginning and the end of the total phase. On each plate therefore we get a history of the visible solar atmosphere for ten seconds; the lengths of the arcs tell how the different chemical constituents are distributed, and their positions tell us exactly what the constituents are. In some of these records it has been roughly estimated that we have to deal with a thousand lines. It is pretty certain, then, that many months of careful measurements will be necessary before we can form a detailed idea of the advance secured.

"As was anticipated, the increased dispersion has distinctly helped us on in our knowledge of the corona. Several beautiful corona images have been secured on both of the prismatic cameras. The want of any visible connection between the materials of the corona and of the chromosphere is again demonstrated. The definition in some of the plates is so good that the bases of the streamers are depicted in the coronal rings, while the prominence and chromosphere rings take no notice of them whatever. This result seems entirely in harmony with the telescopic observations of the structure of the corona which I made with a 3⅝-inch Cooke telescope. The prominences seemed entirely disconnected from the corona structure lying near them, and there was no increase of luminosity as the prominences were approached."

The "flash" spectrum was photographed, both at the beginning and end of totality, with the six-inch and nine-inch prismatic cameras. The results of the six-inch camera with the two prisms (see p. 295) surpass all previous records, about double the number of lines photographed in Novaya Zemlya in 1896 being recorded upon the plates. Photographs of the corona were obtained with a four-inch telescope fed by a cœlostat. Lieut. Blackett, R.N., in charge of the star observations, reported the appearance of some object between Mars and Jupiter, where no star down to the third magnitude occurs on the chart. Prof. Pedler, using a grating spectroscope, observed during the total phase "that the strong arc lines of iron and magnesium were visible on the inner corona, while no spark lines were seen."

Meteorological Phenomena.

Mr. J. Eliot, F.R.S., the Meteorological Reporter to the Government of India, says:—

"The meteorological phenomena accompanying the eclipse were much less striking than was anticipated. Observations expressive of the air were taken with a barometer and a Richard Frère's continuous self-registering barograph. The trace on the barograph on the 22nd was practically identical with those on the 21st and 23rd, and the influence of the solar eclipse was either nil or very small, and will require careful examination of the traces to detect.

"Observations of the temperature of the air were taken by means of six thermometers by Bailey, which had been carefully tested at Kew, and also by means of a Richard Frère's thermograph. The observations show that temperature rose more slowly than usual from 11 a.m. until about totality, when it fell rapidly about 5° F., and was constant for some time after totality.

"This fall in temperature at Viziadurg was partly at first due to the usual change from land winds to sea breezes, which usually takes place at noon. On the day of the eclipse easterly winds prevailed during the previous night and morning until about 12.15 p.m. A short period of calms and light airs obtained until three minutes before totality, when the wind shifted to west, and blew more or less steadily and strongly during the remainder of the day. The only instrument which showed any large influence due to the eclipse was the solar radiation thermometer. It rose steadily from sunrise until about 5 minutes after the commencement (*i.e.* 11.15 a.m.), when it read 144° F. It fell continuously and with increasing rapidity until the end of totality, when it registered 81½° (practically the temperature of the air.) During the latter part of this period it fell at the rate of upwards of 4° in five minutes."

SAHDOL.

The observations at Sahdol (says the *Pioneer* of January 25) were completely successful. The Astronomer Royal exposed seven large plates during totality, and twenty four more during the partial phases. His photographs show the sun's image four inches in diameter. Prof. Turner took twelve pictures during totality, and two plates in polarised light. The photographs taken by the Astronomer Royal and Prof. Turner during the eclipse have been developed, and are highly successful.

Mr. Mitchie-Smith, the Madras Government Astronomer, took seven good photographs with a 40-foot telescope. Photographs of the coronal spectrum were taken by Mr. Moos. Several draughtsmen of recognised ability, including General Strahan, Sir Thomas Holdich, General Woodthorpe, and Colonel Barr, made coronal drawings during totality.

WARDHAGANJ.

The eclipse was observed here perfectly. Twelve photographs of the corona were secured and twenty-four photographs of the spectrum. All the photographs developed are very good.

Captain Hills' corona spectra are excellent, showing a small radial extension of the lines. Captain Hills obtained a series of exposures for the flash at the beginning and end of totality, showing the whole spectroscopic history of the sun's limb, from the solar spectrum through the flash to the prominence.

Mr. Newall found the coronal spectrum too faint at a quarter diameter from the sun's limb for determination of the velocity in the line of sight, but caught the bright lines in the spectrum on another photograph at the end of totality. Mr. Newall observed very strong polarisation in the corona visually, and also observed the green coronal ring with the objective grating spectroscope.

JEUR.

The eclipse party from the Poona College of Science, under Prof. K. D. Naegamvala, had its camp at Jeur, and within two hundred yards of it were the Lick observers, under Prof W. W. Campbell. At Jeur were also the Japanese astronomers, under the direction of Prof. Taero, with Prof. Hiramaya and two assistants. Two miles further south was Mr. C. Burckhalter, with Major Harkness, Captain Dugon, and others. Every branch of eclipse work was represented at Jeur.

All the eclipse parties at this station may well be congratulated on the successful issue of their arduous labours and careful preparation. Thirty good photographs of spectra, fifteen of which are excellent, were secured by Prof. Naegamvala, and about the same number by Prof. Campbell. In the case of the Poona eclipse party these preparations were rendered particularly arduous by the very late arrival of some of the principal instruments sent out from England; Prof. Naegamvala's Cooke 6-inch spectroscope having only arrived on January 11. Upon this instrument two prisms of 45° were mounted. and the length of spectrum given by them was twelve inches. The "flash" spectrum was caught on three plates, and on one spectrum the length from D_3 to H is eight inches. The Maharajah of Kohlapore, who had liberally supported Prof. Naegamvala with funds for the eclipse instruments, specially deputed Prof. Apte to join the Poona party Prof. Apte secured some very interesting observations on the visibility of planets during the course of the phenomenon, and they will be of value in determining the intensity of the corona light.

In addition to the information given in the foregoing extracts, we learn that at the British Astronomical Association's camp at Talni good photographs of the corona were obtained, and Mr. Evershed succeeded in photographing the "flash" spectrum, and in carrying out the whole of his extensive spectroscopic programme. At Gogra, north of Nagpur, Dr. Copeland obtained photographs of the corona with his telescope of 40 feet focal length. Particulars of the instruments employed at the various stations have already been given in NATURE.

PITCHER-PLANTS.[1]

AMONG recent additions to the attractions of Kew Gardens is a house largely devoted to pitcher-plants; and the past year has seen several important additions to our knowledge of this very interesting class of plants.

Pitcher-plants, as enumerated by Prof. Vines, are found in ten genera, distributed through five widely separated natural orders, viz. (1) Sarraceniaceæ (*Sarracenia*, *Darlingtonia*, *Heliamphora*); (2) Nepenthaceæ (*Nepenthes*); (3) Asclepiadaceæ (*Dischidia*); (4) Saxifragaceæ (*Cephalotus*); (5) Lentibulariaceæ (*Utricularia*, *Genlisea*, *Polypompholyx*, *Biovularia*). Of these the only natives of this country are the "Bladder-worts" (*Utricularia*), of which several species are not uncommon in running and standing water. But the genus with which the name is usually associated is *Nepenthes*, the only representative of the order, to which about thirty-two species are assigned by Bentham and Hooker, natives of the East Indian Archipelago, or scattered through Asia, Africa, Madagascar, and Australia;[2] but the number of known species is now considerably larger. About forty species or hybrids are now under cultivation at Kew. Mr. H. J. Veitch—whose firm has done so much for the introduction of these plants into cultivation—in his admirable account of the genus in the *Journal* of the Royal Horticultural Society, gives twenty-four as the actual number of true species in cultivation, in addition to a large number of varieties, and primary, secondary, or tertiary hybrids.

Nepenthes is not grown for the sake of its blossom. The flowers, borne in terminal inflorescences, are small, and of simple type, the perianth consisting of four usually green segments. They are unisexual and diœcious. I find no reference to any insect-visitors to the flowers; and they are probably anemophilous. The interest of these plants centres in the remarkable terminal appendages to the leaves in all the known species, the ascidia or pitchers, which are constructed on a uniform general type, though varying greatly in size, form, and colour. To promote the formation of these pitchers, cultivators usually "stop" the blossoming, so that special cultivation is needed for the production of hybrids. The pitcher itself is generally regarded as an expansion of the petiole or leaf-stalk; Sir Joseph Hooker describes it as a

FIG. 1.—*Nepenthes Sedenii*, one-sixth natural size.

"modification of a gland situated at the apex of the midrib of the leaf." The lid is always completely closed until maturity, and the fluid is excreted within the enclosed chamber.

The composition and properties of this fluid have been the subject of many investigations. Notwithstanding that one or two recent inquirers have come to a contrary conclusion, the observations and experiments of Prof. Vines may be said to have finally settled the point that it contains a true digestive principle. The teleological bias of the eighteenth century connected these pitchers of water with the needs of thirsty travellers or of birds. Linnæus describes the pitchers as "aquam dulcem limpidam, amabilem, confortantem, frigidam suppeditantia, ad necessarium hominis usum," and goes into raptures when adopting the name *Nepenthes* proposed by Breyne:—"Cum enim et haec non Helenæ Nepenthes, certe Botanicis omnibus erit. Quis Botanicorum longissimo itinere profectus, si mirabilem hanc plantam reperiret, non admiratione raperetur, totus attonitus, praeteritorum malorum oblitus, mirificam Creatoris manum dum obstupescens adspiceret?" There are unfortunately two valid arguments against Linnæus's theory:—In the

[1] S. H. Vines, "The Physiology of Pitcher-Plants." (Reprint from *Journ. Roy. Hort. Soc.* vol. xxi., 22 pp.)
S. H. Vines, "The Proteolytic Enzyme of Nepenthes." (*Annals of Botany*, December 1897, pp. 563–584.)
H. J. Veitch, "Nepenthes." (*Journ. Roy. Hort. Soc.* 1897, pp. 226–255.)
F. W. Burbidge, Remarks on the above. (*Tom. cit.* pp. 256–262.)
F. M. Bailey, "Contributions to the Flora of Queensland," vol. i. part 1, July 1897.

[2] Mr. Bailey describes and figures two new species from Queensland.

first place the fluid is absolutely unpotable; and secondly, nearly all the known species of *Nepenthes* grow in climates where the traveller need never be thirsty. Mr. Burbidge states that on the great mountain range of Kina Balou, in North-west Borneo, the "paradise of pitcher-plants," there is a deluge of rain every night in the year, while in the day-time the air is in a constant state of "Scotch mist." The internal surface of the pitcher is provided with a large number of specialised glands, from which the secretion is poured out into the pitcher. The fluid has a slightly acid reaction, and yields a large quantity of solid matter on evaporation; and the most trustworthy analyses that have been made show that the preponderating unorganised constituents are potassium chloride and malic and citric acids, with smaller quantities of soda, lime, and magnesia. The researches of Vines have convinced him that the pitcher secretes an enzyme which has the property of digesting organic substances in the presence of an acid which is always found in the fluid; and that this digestion is not due to the putrefactive bacteria which are always present in the liquid. All the species of *Nepenthes* are either

FIG. 2.—Pitcher of *Nepenthes Dicksoniana*, one-fourth natural size.

epiphytic or grow in wet soil, and agree with other carnivorous plants, such as *Drosera* and *Dionœa*, in having a very reduced root-system; the food-substances obtained through the pitchers thus supplying the lack of nutriment from the soil.

None of the other pitcher-plants, with the possible exception of *Cephalotus*, are, according to Vines, truly carnivorous. In most cases they are insect-traps, but they produce no digestive enzyme; the captured insects are decomposed by the microbes which abound in the fluid, and the products of decomposition absorbed by the plant. In *Darlingtonia*, and in *Sarracenia*, one species of which, the "Side-saddle-plant," is abundant in bogs in the Northern United States and in Canada, the lid is replaced by a hood, and insects are attracted by honey-glands placed near the mouth of the pitcher. In *Dischidia* the pitcher, which has no lid, is not nutritive; its main use appears to be to husband the water required by the plant. The pitchers of *Cephalotus* closely resemble in appearance those of *Nepenthes*. Several species of *Utricularia*, or Bladder-wort, are among the prettiest of our water-plants, with their pale yellow flowers and much-divided leaves, ornamented with the minute bladders, which are closed by a valve opening inwards, thus preventing the escape of innumerable aquatic animals which creep into them. It may be added in conclusion that one of our few native non-chlorophyllous root-parasites, the Tooth-wort (*Lathrœa squamaria*), belonging to the Scrophulariaceæ, has singular hollow underground scale-leaves, which may be regarded as rudimentary pitchers, and resemble those on the exotic terrestrial species of *Utricularia*. Their purpose appears to be the reverse one to that of the pitchers of *Dischidia*, viz. to serve as organs for the excretion of superfluous moisture.

Our illustrations are taken from Mr. Veitch's paper on *Nepenthes* in the *Journal* of the Royal Horticultural Society. Fig. 1, a hybrid known as *N. Sedenii*, a cross between *N. Khasiana* and an unknown species, shows the general habit of the genus. Fig. 2 represents the magnificent pitcher of *N. Dicksoniana*, a cross between *N. Rafflesiana* and *N. Veitchii*. In Fig. 3, *N. Edwardsiana*, Hook. f., a spike of male flowers is shown; also a magnified portion of the glanduliferous surface of the pitcher.

A. W. B.

FIG. 3.—*Nepenthes Edwardsiana.*

A NEW ARTILLERY CHRONOGRAPH.[1]

THE ordinary chronograph used in artillery experiments consists of a falling shutter held suspended by an electromagnet whose circuit is broken by the projectile, which cuts a wire in its passage. Other wires are

[1] Based upon an article in *La Nature*, pp. 97 and 122, 1898.

cut at intervals along the path of the projectile, and as each one is cut a knife is liberated which strikes the shutter and imprints a mark upon it. These marks form a record of the speed of the ball in terms of the known speed of a falling body.

This apparatus, which has been perfected by many devices, is open to a fundamental objection. The release of the shutter and of the knife takes time, a short time may be, but an amount of time which becomes objectionable when intervals as small as one-twentieth of a second have to be dealt with. Projectiles nowadays attain velocities of half a mile per second, and a new and more accurate means is required for dealing with them.

Such an instrument has been devised by Prof. Cushing Crehore, of Dartmouth College, and Mr. Owen Squier, lieutenant of artillery in the United States Army. It is based upon an electro-optical principle of comparatively recent discovery, that known as the Faraday effect. When a beam of light is polarised by a Nicol prism and then sent through another Nicol prism, it is transmitted if the polarisation planes of the two prisms are parallel, but is totally extinguished if the planes are crossed. If, however, a tube containing carbon bisulphide or other rotatory substances is interposed between the crossed Nicols, the light reappears as soon as the tube is exposed to a strong magnetic field. This magnetic field is produced by a coil of wire surrounding the tube, and hence it will be seen at once that an electrical contrivance is possible which interrupts or restores the beam of light. Add a photographic recording apparatus, and the scheme underlying the Crehore-Squier arrangement is complete.

The recording apparatus is shown in Fig. 1. P is the polarising Nicol, A the analyser, T the tube containing the carbon bisulphide and surrounded by the magnetising coil. W is the camera containing the revolving sensitive plate driven by the small motor *m*. The camera is provided with a falling shutter which covers a thin brass disc provided with two small openings. One of these openings admits the polarised light. The other admits light which has had to pass through a hole in a piece of aluminium foil carried on the prong of the vibrating tuning-fork shown in the figure. The vibrations interrupt and restore the light at perfectly constant known intervals, and make a record of dots on the plate, which serve to determine the time for the projectile record. The falling shutter serves to limit the exposure to a portion of one revolution of the plate, and to prevent the superposition of records.

The projectile, in starting from the mouth of the cannon, breaks the first wire and the magnetising circuit, thus extinguishing the light. When it reaches the second wire, it restores the circuit in a manner explained by No. 2 (Fig. 1). B and B′ are terminals of the circuit, A is an insulating piece, and C C are elastic metallic plates kept apart by the insulated wire D. The projectile in its passage whips out the wire D, and allows C C to touch and establish the circuit. The next wire breaks it again, the next restores it, and so on. In the figure, four circuits are indicated, which may be brought into play one after the other, thus providing for the measurement of eight time intervals. By placing these wires at suitable distances from the cannon's mouth, any portion of the path may be minutely investigated.

The most striking information derived from such measurements is that the speed of the projectile goes on increasing for some time after it has left the cannon's mouth. Starting with a muzzle velocity of about 480 m. per second, the projectile increases its speed to, say, 515 m. per second in traversing the first 6 feet from the mouth. It is only after having travelled some 25 yards that the projectile is reduced to its original muzzle velocity. This proves that the impulse of the expanding gas is felt some distance along the path of the projectile.

By a modification of the arrangement described, the inventors have also succeeded in determining the speed of the projectile inside the barrel of the gun. For this purpose they secured a wooden lath to the cone of the projectile (Fig. 2), provided with rings of metal at decreasing intervals. These rings were connected among themselves and to the projectile by a wire running along the length of the rod, the whole being smoothed and turned into an accurate cylindrical shape. A wooden block, A (Fig 3), was fastened on the muzzle of the gun by means of screw clamps, and a brass collar with steel rings, C, was made to embrace the rod, which in the original position of the projectile just projected from the muzzle.

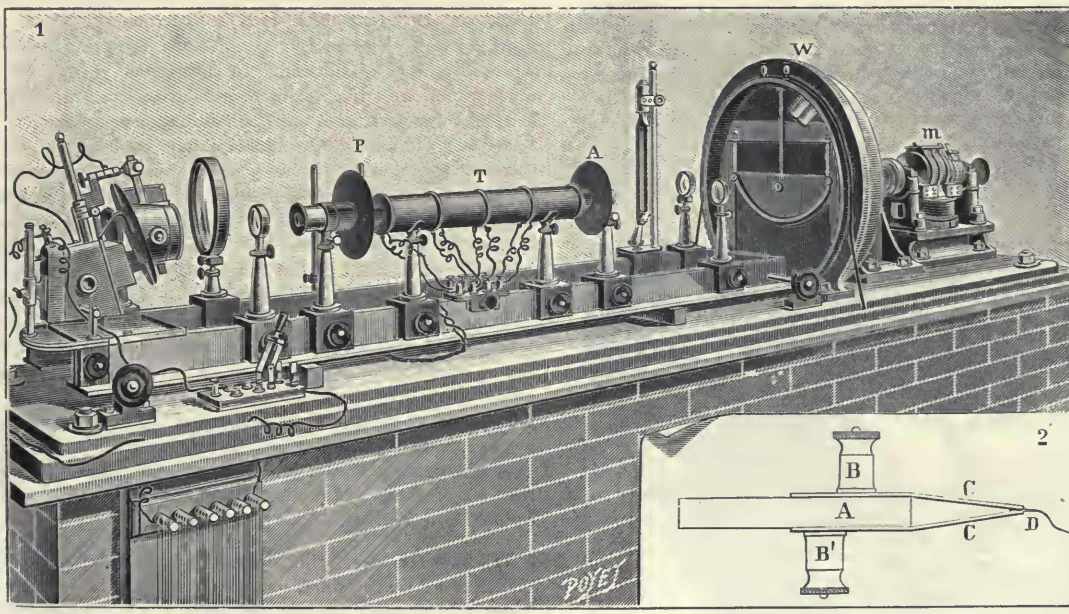


FIG. 1.—Recording apparatus. T tube containing carbon bisulphide surrounded by magnetising coils. W camera. No 2, arrangement for closing circuit.

A circuit through the steel rings, the brass collar, the metallic rings on the rod, the projectile and the body of the gun was completed whenever the brass collar touched one of the rings on the rod. It was broken when the wooden portions passed, and so an alternate transmission and extinction of the polarised beam was brought about, which served the same purpose as in the arrangement first described. The curves obtained showed a constant acceleration of the projectile within the barrel, which would

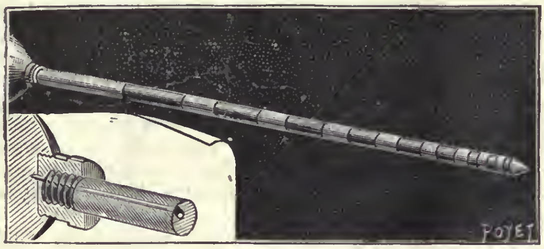


Fig. 2.—Apparatus for measuring velocity of projectile inside the barrel.

indicate a constant pressure of the gas. But unfortunately no complete records were obtained, the rods having broken off half-way through the barrel.

The most remarkable circumstance of all these trials lies in the extreme smallness of the intervals measured. In some experiments ten points were taken along a length of 72 cm., which corresponds to a duration of 0·005 seconds, and reduces the interval observed to 0·0005 seconds.

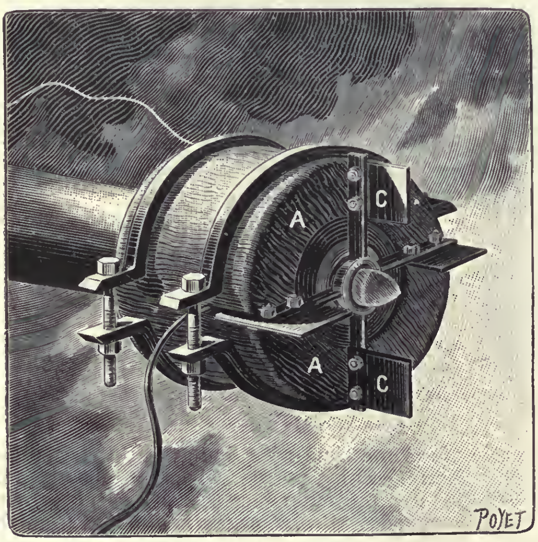


Fig. 3.—Block attached to muzzle for making circuit.

Needless to say, the apparatus may with equal success be applied to other fields of micro-chronographic investigation.

NOTES.

At the meeting of the Royal Society next Thursday, February 24, for the discussion of the scientific advantages of an Antarctic expedition, the following are likely to take part in the discussion which will be opened by Dr. John Murray:—The Duke of Argyll, Sir Clements Markham, Sir Joseph Hooker, Sir Archibald Geikie, Dr. Neumayer (Director of the Deutsche Seewarte), Dr. Sclater (Secretary of the Zoological Society), Prof. D'Arcy Thompson, and others.

Prof. Alexander Agassiz writes to Prof. Ray Lankester from Sura, Fiji, under date January 3, as follows: "I got here first days in November, and found my steamer awaiting me; started the day after reaching Sura, and have been on the full run ever since. I have learned more about coral reefs than on all my former expeditions. Naturally my experience elsewhere has been of great service. The problem is getting more and more complicated. My boring was a fizzle. I only got to 80 feet; but in a region where there are elevated reefs nearly 1000 feet thick, that means nothing. From all I hear about the Funafuti boring (700 feet), and from what Prof. David writes, I fancy the bore-core will not bring us any nearer to a conclusion. It certainly can not help us to ascertain how atolls have been formed."

That until a few days ago (February 10) there lived in Eaton Square a nephew of Sir John Moore, and a man who many years ago attained a considerable distinction in geology, was little known to the present generation of scientific workers. John Carrick Moore was born in 1804, and inherited an estate in the northern part of The Rhinns of Wigtownshire, near Stranraer. He became a Fellow of the Geological Society in 1838, and two years later read a paper on the rocks which form the west shore of the bay of Loch Ryan, at the head of which Stranraer is situated. In subsequent years he devoted much attention to the fossiliferous Silurian strata of Wigtownshire and Ayrshire, and contributed the earliest account of the rocks near Carrick. He likewise published accounts of the Tertiary fossils of St. Domingo and Jamaica. For many years he served on the Council of the Geological Society, terminating his official connection in 1875. In 1846 he was appointed one of the Honorary Secretaries, and later on for several years he was a Vice-President of the same Society. He was elected a Fellow of the Royal Society in 1856. Educated at Queen's College, Cambridge, he early gained a sound knowledge of mathematics and physics, and in after years he contributed a few articles to the *Philosophical Magazine*, dealing with the influence of the obliquity of the ecliptic on climate, and criticising some of the principles enunciated by Ramsay with regard to the erosion of lake basins. Living to the advanced age of over ninety-four, Moore long outlived the majority of his old friends, of whom Murchison was one with whom he was intimately associated.

We have received further correspondence relating to the two Societies in Lincolnshire, to which reference was made in our issues of December 30 and February 3. It appears that the older Society, the Lincolnshire Naturalists' Union, does not regard with unmixed friendliness the newer and possibly more vigorous Science Society. Into this unfortunate conflict of interests it is not our province to enter, and we can only repeat with renewed emphasis that it is a most serious mistake to allow the spirit of rivalry to enter into the matter at all. The welfare of both Societies can only suffer, and the progress of science in the county can only be retarded by friction. The Lincolnshire Science Society explains its origin by accusing the Union of failing to carry out the objects for which it was founded. There may or may not be truth in the accusation, but we are bound to admit that evidence of scientific activity on the part of the Union has not been obtainable. We cannot find the latter body among the corresponding societies of the British Association; neither can we learn that any publication has been issued under its auspices. Attention may be called to an article by Prof. Meldola, on the work of local societies, published in these columns in 1896 (vol. liv. p. 114), in which some of the causes of the decay of such societies are pointed out, and the advantages of federation insisted upon. We can only hope that Lincolnshire will not present to the scientific world a divided front on a

question in which both parties are really striving for the same end.

IT is announced that in connection with the completion of his twenty-fifth year of office as Woodwardian Professor of Geology at Cambridge, Prof. T. M'Kenny Hughes, F.R.S., is to be the recipient of an illuminated address, to be presented at a public dinner to be held in London on Saturday, the 26th inst. Sir Archibald Geikie has consented to preside.

THE death is announced of Dr. Rudolf Leuckart, professor of zoology and zootomy at Leipzig.

PROF. ALEXANDER GRAHAM BELL has been elected president of the National Geographic Society, Washington.

MANY men of science will grieve to learn that there is no improvement in the condition of Sir Richard Quain, who has been in ill-health for some time, and is gradually getting weaker.

WE regret to see the report that Sir William Dawson, C.M.G., F.R.S., formerly principal and vice-chancellor of the M'Gill University, Montreal, has had a stroke of paralysis.

DR. NANSEN has consented to deliver a lecture at the Queen's Hall on the evening of Monday next, February 21. Lord Lister will take the chair.

The organisation of the Corps of Electrical Engineers, Royal Engineers (Volunteers), has now been completed, and applications for membership may be made to the adjutant, Captain Brady, R.E., at the headquarters of the Corps, 13 Victoria Street, S.W. Major J. Hopkinson, F.R S., is in command, and Lord Kelvin is honorary colonel. The War Office is offering every encouragement to the development of this new Corps of Volunteers.

IN the House of Commons on Monday, Sir H. Vincent asked the Under-Secretary of State for Foreign Affairs what grant would be proposed from public funds for the representation of the United Kingdom at the Paris Exhibition of 1900; and if he could state what sums Germany, the United States, and Italy proposed to allocate for the representation of their national industries. In reply Mr. Curzon said:—It is proposed to ask Parliament for a grant of 75,000*l.* to provide for the expenses connected with the British section. The German Government has sanctioned a grant-in-aid of 5 million marks, or about 250,000*l.* The United States Government has made a Treasury estimate of 350,000 dollars, or about 70,000*l.* In Italy nothing has yet been officially settled as to the exact amount to be devoted to this purpose.

A GREAT authority on iron and steel has passed away in the person of Prof. Styffe, who died in Stockholm on February 3, having just entered his seventy-fifth year. After completing his studies at the University of Upsala (says *Engineering*) he passed through the School of Mines at Falun, and was afterwards engaged as a mining engineer in the Sala silver mines, but he was soon called by his Government to be the chief director of the Royal Technical Institution at Stockholm. Here he rendered great services during more than a quarter of a century, and was consulted at the same time by the Board of Iron and Steel Works (Jernkontor) in Sweden. When the construction of railways was begun in Sweden, some forty years ago, the question naturally arose of using the excellent native iron and steel for the railway plant, and the State appointed a Committee to make careful researches as to its adaptability for the purpose. Director Styffe was appointed chief of this Committee, and carried out these researches during a period of five years in the most minute and scientific manner. His results were published in the *Annals* of the Jernkontor, or Board of Iron and Steel Works in Sweden. They were translated into English by C. P. Sandberg, and published under the title of "The Elasticity, Extensibility, and Tensile Strength of Iron and Steel." The work caused a great deal of interest in the engineering press at the time. Styffe was juror for Sweden for mining and metallurgy at the London International Exhibition in 1862, and at the subsequent exhibitions in Paris and Vienna. Last summer he was present as an honorary member of the International Congress for the Testing of Materials at Stockholm, and was duly honoured for his long and valuable services.

AMERICAN geographers appear to be far from pleased with the projected plans of Captain Sverdrup. He purposes this summer to use the *Fram*, with Dr. Nansen's approval, for the exploration of the northern shores of Greenland. These plans, it is objected, materially affect and invade Lieut. Peary's field of work, who has not only already done a great deal on the north coast of Greenland, but has for a long time had in view a project for its continued exploration this summer. The American Geographical Society, in its recently-issued quarterly *Bulletin*, publishes two strong protests. It is asserted that Captain Sverdrup, by setting out at the same time, adopting Peary's route and aims, utilising his experience, and interfering with his resources of men and dogs in North Greenland, will frustrate the labour of ten years, and turn to advantage all that skill and courage has already accomplished. The caustic comment is made: "There is no legal impediment in Captain Sverdrup's way. He can do these things if he will, and men will remember him as the one Arctic voyager whom they would gladly forget."

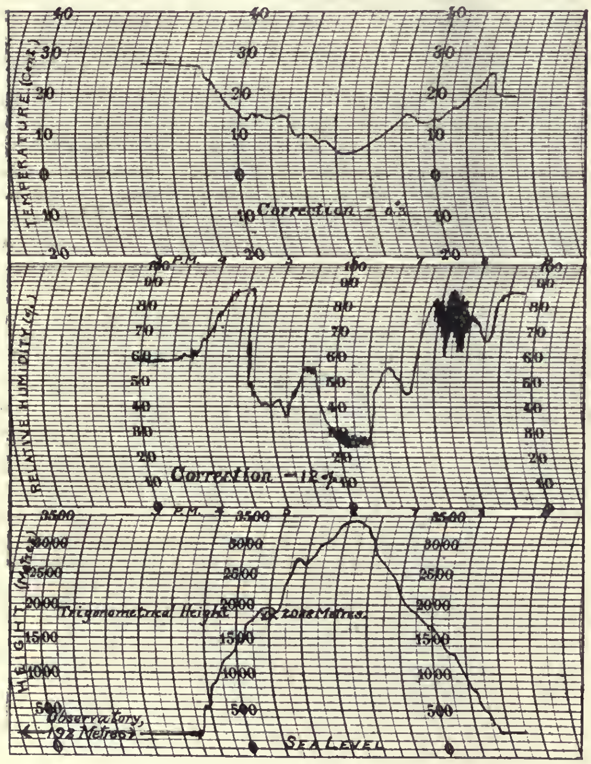
THE "Year-Book" of the Royal Society, No. 2, 1897–98, has just appeared. There are several features in it which lend additional interest, and form an improvement on the last issue. For instance, the scheme of regulations for the administration of the Publication Grant of 1000*l.* from H.M. Treasury is given, as well as a good deal of information regarding the annual Government Grant for scientific research, such as an account of the appropriations, and a list of the Boards recommending assignments from the fund. A note on p. 1 states that applications for grants, and the reports on them, must be sent in by January 31; but the late issue of this "Year-Book" (apparently it is brought down to November 30, in each year) renders the information valueless, at any rate for the current year. The President's address and other anniversary matter is now omitted from the *Proceedings*, and published instead in the "Year-Book."

A STRIKING novelty in vacuum tubes is described by Prof. Trowbridge and Mr. Burbank in the February number of the *Philosophical Magazine*. The space between anode and kathode is done away with, and a continuous wire is led through the exhausted tube, which is then inserted in a circuit containing a spark gap and one of Trowbridge's improved "rheostatic machines." The latter is charged by means of a battery of 10,000 storage cells. The condensers constituting the machine are charged in parallel, and then discharged in series, thus giving rise to a voltage which may be made to approach a million. It is not surprising that by this means novel results are obtained. The tubes glow all over with a brilliant phosphorescence. X-rays are developed; but their photographic effect cannot well be brought into evidence, owing to the fact that brush discharges pass between the tube and the sensitive plate, which on development has a star-spangled appearance. The skin of the hand shows all the symptoms of X-ray burning. An aluminium mirror attached to the wire inside the tube throws a beam of kathode rays upon the wall, which may be deflected by a piece of tinfoil. At extreme exhaustions no difference is noticeable

whether the tube is on the anode or the kathode side of the spark gap. The distinction between anode and kathode rays disappears.

FROM the Blue Hill Meteorological Observatory, of which Mr. A. Lawrence Rotch is director, we have received a *Bulletin* (the first issued from the Observatory), by Mr. S. P. Fergusson, on the highest kite ascensions in 1897. On September 19, 1897, as already described in NATURE (vol. lvi. p. 540), the meteorograph was raised to a height of 3013 metres above sea-level. The highest kite was 40 metres above the meteorograph, or 3052 metres above sea-level. The kites and meteorograph were sent up from near the summit of the hill, which is 192 metres above sea-level. On October 15, 1897, the meteorograph was raised to a height of 3571 metres above sea-level, or 558 metres higher than on September 19. The highest kite was 40 metres above the instrument, or 3611 metres above sea-level. At the top of the line were a Lamson ribbed kite with curved surfaces, having an area of 6·60 square metres, and a self-adjusting Hargrave kite, having an area of 3·35 square metres. Two other Hargrave kites, each having an area of 2·13 square metres, were respectively attached at distances of 2000 and 3500 metres from the top of the line. The length of line employed was 6300 metres, and the pull, when all the line was in the air, varied between 56 and 68 kilograms. The instrument left the ground at 3.48 p.m., and reached the highest point at 6 p.m. The work of reeling in the line began at 6 p.m., and the instrument reached the ground again at 8.20 p.m. The meteorogram obtained during this flight is one of the best that has been secured, being complete, with very clear and smooth lines. It is here reproduced from the *Bulletin*. At the highest point reached the temperature was 5·0° C., and at the Observatory it was 22·2°. An interesting feature of this flight was the passing of the meteorograph through the cumulus and alto-cumulus levels of clouds, as shown by the increase followed by a decrease of humidity at heights of 1500 and 2800 metres. At the Observatory the wind was from the south-west during the entire flight, and the velocity varied between 5·4 and 8·0 metres per second, true velocity. Above the height of 1000 metres the direction of the wind was north-west.

KITE METEOROGRAM OF OCT. 15, 1897.



PROF. GEORGE M. STRATTON, of the University of California, has made a novel experiment in inverted vision by wearing for eight days a mask fitted with lenses which invert the visual image, thus projecting it upon the retina in an erect instead of the normal inverted position. He soon learned to refer all objects to their correct positions, in other words to see them right side up; but, on removing the apparatus at the expiration of eight days, everything appeared to be upside down at first. He therefore concludes that the seeing of objects right side up is due to a mental rectification of the visual image actually projected upon the retina.

AT the meeting of the New York Academy of Sciences on January 24, Mr. E. L. Thorndike, of Columbia University, gave an account of a long series of interesting experiments on comparative psychology. These experiments were made upon cats, chickens, dogs, monkeys and other animals, and were supplemented by the experience of professional animal trainers. According to a report in *Science*, cats were placed in boxes with doors so arranged that they could be opened from the inside in various ways, in one set of experiments by pressing a latch, in another by pulling a cord, by pulling a hook attached to a cord, or by turning a button. Again the arrangement was more complicated, and two or three separate movements had to be combined in order to release the door and let the animal out to reach the fish placed outside the cage. Curves were given showing the rate at which the kittens learned the various tricks, the time taken to get out becoming gradually shorter. The trick was always learned by accident; one lucky hit would prepare the way for another. There was no trace of rational inference. Seeing another animal do the trick a hundred times was no help. Nor was it possible to teach the trick by taking the kitten's paw and putting it on the latch, and so opening the door, no matter how often it was repeated. A habit once formed artificially will overpower natural instincts. A chicken that had been compelled to jump from a box to the floor in a roundabout way by a cardboard placed in its way, felt unable to jump down to its food directly when the card was taken away.

SIR A. HARDINGE'S report on the East Africa Protectorate, 1897 (c.-8683), contains a careful summary of the manners and habits of the native tribes. There are many broken or slave tribes, besides full tribes. One common characteristic appears to be the looseness of the tribal tie and the small amount of direct government, either by chief or council. The Wagiriama of the Malindi district are a vigorous and handsome race of a dark brown, almost black, colour; and closely allied to them, though politically distinct, are the Wakauma. They have a loose republican sort of organisation, based partly on tribal subdivisions and partly on a kind of freemasonry known as "kambi," which involves several degrees, each attended by its special ceremony of initiation. The Wapokomo of the Tana River district are a fairly handsome and intelligent Bantu race, dwelling in thick clusters of beehive-shaped straw huts all along both sides of the river. The Wakamba occupy the Attri district, and a very useful table is given of the internal subdivisions so far as they are known. Each family occupies its own "boma" or hamlet, and a man on marrying usually forms a boma of his own, consisting at first, perhaps, only of his own hut, but gradually expanding into a hamlet and thence into a village, of which its founder is regarded as the chief. Here is Sir Henry Maine's famous patriarchal family in the making; but we should much

like to have further particulars and assurance that this description is justified by accurate scientific observation. The tribes of the interior have neither idols, priests, nor temples; but there is a vague general belief in spirits, mostly evil, dwelling in or near certain trees or sacred spots, in witchcraft and in ghosts, as well as a more vague belief in a kind of supreme being. The various tribes have each their sacred animal or totem, which it is unlawful for them to eat or kill. Altogether this is an excellent report, and the accompanying maps make it of some value to anthropological students.

AN exploration of considerable importance has lately been undertaken by the East Siberian branch of the Russian Geographical Society (*Izvestia*, xvii. 1, 2; xviii. 3). M. Sibiryakoff, a well-known owner of gold-mines, having put a large sum of money at the disposal of this society, about twelve persons, thoroughly acquainted with the Yakutsk province from a many years' stay in different remote parts of it as political exiles, were invited to join in a detailed exploration—anthropological, ethnographical, linguistic, and economical—of the Yakut and Tungus population of the province. The exploration, which has now been carried on for three years, has resulted in the accumulation of most valuable materials. Anthropological measurements and photographs of Yakuts, Tunguses, and Russians were made by MM. Gekker, Mainoff, and Vitashevskiy, on a very large scale, and part of the data has already been published in the *Memoirs* of the East Siberian branch. Special excursions to inquire into the economical conditions of the population were made; all materials which are kept in the archives of the local administration, and which could be utilised for historical, ethnographical or economical purposes, were consulted. The common law of the natives was carefully studied, as also their folk-lore and their traditions; and, finally, the exploration was extended by the exiles who are kept in Sredne-kolymsk to the extremely interesting, and almost quite unknown, Yukaghires of the Arctic littoral; while S. Kovalik has nearly prepared for print a complete history and ethnographical description of the Yakuts of the Olekma region. At the same time E. Pekarsky, who speaks in Yakut as in his mother tongue, has prepared for publication a most elaborate and highly appreciated Yakut dictionary. For compiling it, he has utilised all formerly printed materials, as also many MSS. which were kept in the library of the East Siberian branch, and a considerable amount of notes collected by his comrades within the last fifteen years. A special sum was subscribed by M. Sibiryakoff for the publication of this dictionary.

A NEW process for preventing the decay of wood has recently been introduced, and extensive works set up at Millwall for treating timber. The inventor, Mr. Samuel Edward Haskin, has been engaged for the last twenty years in experimenting and perfecting the process in America. Hitherto the method adopted for preventing wood from decay has been by the withdrawal of the sap, and the injection of creosote or other antiseptic substances. The Haskin process, on the contrary, retains the sap, but destroys its germinative principle. To procure this result the wood to be treated is placed in a cylindrical heating-chamber, and submitted to a medium of superheated air at a pressure fourteen times as great as the normal pressure of the air. The substances composing the sap are by this means chemically changed, and form a powerful antiseptic mixture, which becomes consolidated with the fibre, thus strengthening and preserving the wood.

MR. H. L. RUSSELL is continuing his experimental investigations on the ripening of cheese, and, in conjunction with Mr. S. M. Babcock, has recently published an important paper describing what the authors consider to be a new factor in this process. Hitherto these changes have been solely ascribed to the direct or indirect action of the bacteria that are present in the milk, and the lactic acid bacteria have been credited with playing the chief *rôle* in this matter. But Russell and Babcock have shown that profound changes of a physical and chemical nature occur in milk in which bacterial fermentations have been excluded, and by means of carefully carried out experiments they have obtained results which they consider justify the assumption that these changes are of a non-vital character, and due to the presence of ready-formed enzymes in the milk as obtained from the cow. They have, moreover, succeeded in separating out proteid-converting (proteolytic) enzymes which, when applied to milk, exerted a curdling as well as a digestive function. The authors believe that the ripening of hard cheese, instead of being due solely to bacteria, is caused by the joint action of both organised (bacteria) and unorganised ferments (enzymes). This is a novel suggestion, and will doubtless stimulate research in this direction. Meanwhile the characteristic flavours of cheeses still remains a problem, and it is probable that in this department investigations may teach us to credit bacteria with yet more importance than we are even at present inclined to ascribe to them. The authors' memoir is to be found in the fourteenth annual report of the Wisconsin Agricultural Experiment Station, issued in December last. Agricultural research in this country may well take a lesson from the splendid work which flows so continually from the recently equipped scientific stations in the United States; formerly the investigator had but little more than German journals to take into consideration, but now he has to refer on all sides to American publications.

THE *Bulletin* No. 2 (December 1897) of the Laboratories of Natural History of the State University of Iowa consists of two articles—"The Coleoptera of the Lower Rio Grande Valley," by Mr. H. F. Wickham, and "The Ferns of Nicaragua," by Mr. B. Shimek. In the latter paper the number of species enumerated, including Ophioglossaceæ and Marattiaceæ, is 198, belonging to 39 genera, justifying the author's description of Tropical America as the "fern-paradise of the earth." (In the British Islands we have 38 species belonging to 17 genera.) The larger number of these were collected by the author in a botanical expedition undertaken for the University. The high mountains in close proximity to the sea afford a climate remarkably well adapted for the growth of ferns, which are stated to form the most conspicuous feature of the vegetation excepting palms. A large number are epiphytic, and they vary in size from tiny species of *Trichomanes*, with fronds only a fraction of an inch in height, to clinging "vines" like *Blechnum volubile*, single fronds of which often exceed 30 feet in length, or to splendid tree-ferns. The paper is illustrated by twenty excellent plates.

Farmers' Bulletin, No. 68, of the U.S. Department of Agriculture is devoted to a description of the black rot of the cabbage, and the best remedies or preventives, by Mr. E. F. Smith. The disease is due to *Pseudomonas campestris*, a parasite especially destructive to plants belonging to the Cruciferæ.

MESSRS. SWAN SONNENSCHEIN AND CO. have in the press a work on "Epidemic Diphtheria," by Dr. Arthur Newsholme. The work embodies a research on the origin and spread of the disease, from an international standpoint.

MESSRS. CROSBY LOCKWOOD AND SON ask us to state that the forthcoming work on "Submarine Telegraphs: their History, Construction, and Working," by Mr. Charles Bright, will be published very shortly, and to remind our readers that the subscription price ceases to apply on the date of publication.

A THIRD and revised edition of Mr. W. Arnold Buffum's interesting book on amber, entitled "The Tears of the Heliades,

or Amber as a Gem," has been published by Messrs. Sampson Low, Marston and Co., Ltd. The volume brings together many facts of interest concerning the origin and decorative uses of amber.

THE determination of the density of a gas has, till comparatively recently, been regarded as an operation of great difficulty, requiring elaborate apparatus and a large quantity of material. In the course of his researches on argon and helium, however, Prof. Ramsay has shown that it is possible by direct weighing to arrive at a reasonably accurate result upon as small a quantity as thirty cubic centimetres. In two recent numbers of the *Comptes rendus* are two contributions to this subject by M. Th. Schlœsing, jun., in which he gives a most ingenious method of measuring the density of a gas, based upon the balancing of two columns of the gases in a U-tube. Two vertical tubes about one metre in length communicate at their lower ends by a three-way tap; in one is placed an easily absorbable gas of known density, such as carbon dioxide, and in the other the gas under examination. On allowing the columns to communicate through the tap, a state of equilibrium between the gas, carbon dioxide, and air is set up after about four minutes, and the level of the invisible surfaces of separation then determined by absorbing the carbon dioxide with potash. In order to reduce the unavoidable diffusion of the gases, very narrow tubes were taken (1·6 mm. to 2·7 mm. in diameter), with the resulting advantage of reducing the quantity necessary for a determination. In the second paper data are given for nitrogen, oxygen, and methane, from which it would appear that an accuracy of 1/1000 is obtainable upon five to seven cubic centimetres of gas. With hydrogen only was there a failure, the mutual diffusion of the two gases being too rapid to allow of equilibrium being set up. There can be no doubt that the method will admit of many useful applications.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. Robert O'Callaghan; a Horned Lizard (*Phrynosoma cornutum*) from California, presented by Mr. Charles Iseard; three Shaw's Gerbilles (*Gerbillus shawi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

A PROBABLE NEW STAR.—In Circular No. 45 from the Wolsingham Observatory, dated February 14, the Rev. T. E. Espin states that an eighth-magnitude red star not in B.D. was found the previous night, its place being R.A. 7h. 12m. 16s., Decl. + 32° 19′ (1855).

NEW PHOTOGRAPHS OF NEBULÆ.—With a reflector having the extraordinary ratio of 1 metre aperture to 3 metres focal length, M. A. Rabourdin has taken some remarkable photographs of several nebulæ at the Meudon Observatory, and he gives a detailed account of them in *Comptes rendus* for January 31. On the ring nebula in Lyra he made three exposures—of twenty, thirty-five and fifty-five minutes. "These three plates," he remarks, "show that for this annular nebula the nebulosity of the interior increases with the time of exposure, whilst the total diameter increases very little. The final result is an elliptical nebula in place of the annular one taken with the short exposure. The photographs also show very plainly a star at the centre of the ring, which is, moreover, visible to the eye in the telescope; but neither the drawings of Herschel in 1833, Lord Rosse in 1844, nor that of Trouvelot in 1873, give any indication of it. Hence this would tend to show a comparatively recent change."

With an exposure of fifty minutes on the planetary nebula in Aquarius, a photograph was obtained showing two protuberances diametrically opposite, which would lead one to suppose that the central globe is surrounded by a diffuse belt analogous to Saturn's ring.

A photograph of the nebula in Andromeda, with only one hour exposure, is said to exhibit as much detail as those previously obtained with four times the exposure; and the nebula is so extensive, that it was quite impossible to photograph the whole region on one single plate.

A photograph of the nebula in Triangula shows that it is a beautiful spiral one.

The region of the Pleiades was also photographed, giving one hour exposure, with Alcyone in the centre of the plate. Even with this comparatively short exposure, MM. Henry have discovered nebulæ absolutely invisible in the telescope, enriching this region still more with two other new nebulæ surrounding Atlas and Pleione. This photograph also shows more than the beautiful chart of the Pleiades taken by MM. Henry, and exhibits additional streams of nebulous matter which apparently bind together certain stars of this group.

CARBON IN THE CHROMOSPHERE.—That carbon existed in the solar spectrum itself was at one time a matter of doubt, but its existence was established long ago by the early researches of Sir Norman Lockyer. Now, with the aid of the 40-inch telescope of the Yerkes Observatory, Prof. Hale has observed the presence of carbon in the chromosphere, and his paper on this subject is to be found in the December number of the *Astrophysical Journal*. The observations were made last September, and the green fluting near *b* was distinctly seen as a bright reversal in the chromosphere. M. Deslandres, who was visiting the observatory at the time, had no difficulty in seeing the lines, and they have since been observed by Profs. Runge and Keeler.

These results are interesting, in the light of the fact that the photographs of the total eclipse of 1896 show a decided influence of the prominences on the corona, and the examination of the corona itself at the last eclipse, for the presence of carbon might possibly have led to fruitful results.

PARALLAX OF SIRIUS.—In the *Monthly Notices* for January, Dr. Gill discusses a series of observations for the parallax of Sirius, made by him in 1888-89 with the Cape heliometer. The comparison stars used were both of 8·7 magnitude; one, which he denotes by γ, being 4310″ distant, and the other, δ, 4536″ away from Sirius, with respective position angles of 279°·17 and 101°·26.

From these observations he deduces a value of $0''{\cdot}370 \pm 0''{\cdot}0097$, which is in remarkably close agreement with his well-known result of $0''{\cdot}370 \pm 0''{\cdot}009$ from his 1881-83 observations.

Dr. Gill states that by this method of measurement it was possible to determine parallaxes so small as 1/50 of a second with some confidence—a degree of accuracy not previously attained in astronomical researches of any kind. He therefore thinks we may regard the parallax of Sirius as now satisfactorily determined, and that the corrections depending on a parallax of $0''{\cdot}37$ might with advantage be introduced in the apparent places of Sirius given in the national ephemerides.

WE note with pleasure that Mr. A. C. D. Crommelin, in the *Monthly Notices* for January, continues his paper which appeared in the December number, on the "Ephemeris for physical observations of Jupiter, 1898." We had been so long accustomed to seeing the late Dr. Marth's name attached to these and similar tables for the moon and other planets, that it was doubtful who would volunteer to fill his place; but we are glad to find that one so able as Mr. Crommelin has undertaken this task.

THE ATOMIC WEIGHTS OF NICKEL AND COBALT.

THE determination of the atomic weights of nickel and cobalt has attracted a considerable amount of attention during the last few years, the numbers obtained by different workers exhibiting relatively startling variations. Thus, including only the four most recent results, the values for cobalt vary between 58·78 (Hempel and Thiele, 1895) and 60·12 (Schützenberger, 1892). Similar variations observed for nickel by Krüss, led him to the conclusion that this metal contained a new element, to which he gave the name of "gnomium"; but recent work has not tended to confirm this view. In the *Proceedings* of the American Academy of Arts and Sciences for November and December last, are two important contributions to this subject, by Richards and Cushman and

Richards and Baxter respectively, giving the results of analyses of the bromides of nickel and cobalt; which show in a decisive manner that properly purified nickel and cobalt are homogeneous substances. After stating the advantages pertaining to the use of the bromides, for the sublimation and bottling of which a highly ingenious apparatus is described, they show how two totally distinct methods of purification, starting from metals of different origin, lead to a bromide of the same composition.

For nickel bromide the material was obtained from two sources—the "pure" nickel of commerce, and Mond nickel prepared by the carbon monoxide process. The steps for the purification of the first of these included fractional precipitation as sulphide, then as hydroxide, conversion of this through the bromide into the violet crystalline ammonia compound $NiBr_2.6NH_3$, and this, after several recrystallisations, converted through the oxide into spongy nickel. For the Mond nickel, in which a little iron was practically the only impurity, the same process was adopted, except that to remove alkalis the hydroxide was converted into sulphate and the latter subjected to electrolysis several times. After conversion into bromide, these were analysed, and for the final analyses further purification was attempted by repeated deposition by electrolysis. All three samples gave identical results, 58·69, for the atomic weight of nickel (O = 16).

The cobalt was purified with equal care, the cobalt bromide being obtained by two distinct methods of purification, the one through potassium-cobalt nitrite, and the other through a cobaltamine, and these again purified by a combination of both processes. The results of the three series were practically identical, the atomic weight of cobalt being 58·99 (O = 16).

While recognising that data obtained from one compound only are not sufficient to finally settle the atomic weights of these metals, the authors conclude that if "gnomium" exists, it must have an atomic weight about equal to that of nickel and cobalt; and hence, that the wide variations observed in the results of other experimenters cannot be considered a valid argument in favour of the late Prof. Krüss's doubtful discovery.

CRATER LAKE, OREGON.

THE Mazamas of the State of Oregon are no ancient tribe of redskins, but the members of a very active and most praiseworthy mountaineering club in the city of Portland. The President in his last annual address observed: "Within two years the name *Mazama* has been heard throughout the world, and to-day it stands as a synonym for all that is unique, progressive and inspiring in mountaineering societies"; and even if the European Alpine clubs hesitate to accept this statement in its entirety, all must agree that the second number of the publication entitled *Mazama* justifies the "guid conceit" the members of that lively club have of themselves. As no American University commands respect without a rousing "yell," so no mountaineering club can organise excursions without a "cheer," and this is the Mazamas':—

> "Three cheers for the mountaineers,
> 'Rah! 'rah! 'rah!
> Nesika klatawa sahele
> Ma-za-ma."

The obscurest line is Chinook jargon for "We go up." Led with such a slogan, the Oregon Highlanders have carried many peaks by storm, and have opened to the public much of the grand mountain scenery of the Cascade Range. Part 2 of *Mazama* is devoted to the remarkable natural feature known as Crater Lake, to which the club made an excursion in 1896. The description is not a piece of amateur geography, but a solid description put together out of reports by the first scientific authorities.

Crater Lake is situated nearly in 43° N. and 122° W. It may be reached from several stations on the railway between Portland, Oregon, and San Francisco, by roads, usually bad, and as yet there is no house of any kind near its shore. Leaving the Southern Pacific Railway at Midford, one may reach it by 85 miles of road up the Rogue River valley. From Ashland a road of 95 miles must be traversed; but the best road—one which is practicable for bicycles—is from Ager, Cal., past the deserted Fort Klamath, a distance of 116 miles. The whole country is covered with dense coniferous forest. In approaching the lake, there is a steep climb for about three miles; then the forest-clad mountain slope gives place to a nearly level plateau, carpeted in autumn with flowers, across which one walks a few hundred yards with nothing to see, until suddenly a precipice of 900 feet yawns at one's very feet, and deep below the dazzling blue water of Crater Lake spreads far and wide. The weird grandeur of the scene accounts to the full for the superstitious awe with which the Indians of the district regard the lake.

Crater Lake may have been discovered in 1847, but the first authentic account of its existence came from a composite party of prospectors in 1853. A party of Californian gold-seekers crossed secretly into Oregon to search for a mythical lost digging of fabulous richness, and for as long a time as provisions lasted they were followed by a party of Oregonians who could not be shaken off. The rivals united at last, and, continuing the search for gold together, came upon Crater Lake, which they named "Deep Blue Lake," or "Lake Mystery." The next recorded visits were in 1862, 1865, and 1869. From that time its fame began to spread, but it was not geologically examined by experts until 1883. In 1885 a party of the United States Geological Survey, under Captain Dutton, was detailed to sound the lake and make a topographical survey of its surroundings; and a detailed contour map was constructed.

The roughly circular lake, from four to six miles in diameter, is without outlet, and without tributaries; the upper edge of the rim is a water-parting, from which streams radiate down the slopes towards the sea through deep cut valleys. The outer slopes have a gradient of from 10° to 15°, and are richly wooded. The inner slopes are precipitous, and allow of a descent being made to the water only at one or two points. The water-level stands 6239 feet above sea-level, and the crest of the rim varies from 520 to 1989 feet higher. The greatest depth ascertained in the lake is 2008 feet. A relief model of the lake and its surroundings has been constructed, and shows a remarkable similarity to the larger ring-craters of the moon. One island of some size rises in the lake in the form of a cinder-cone, bearing a well-marked crater on its summit. It goes by the name of Wizard Island, and a fantastically weathered islet is named the Phantom Ship.

FIG. 1.—Photograph of a relief model of Crater Lake.

A description of the geology of the region is given by Mr. J. S. Diller. The rim is composed entirely of lava streams and beds of volcanic conglomerate dipping away from the lake. At one point, however, there is a remarkable lava-flow, which appears to have run down the inner slope.

The lavas of the rim are mainly andesites forming the earlier flows, but rhyolites associated with pumice occur among the later. There is no basalt on the rim, but basalts occur on the outer slopes several miles from the lake, being related to cinder cones adnate to the central crater. Numerous andesite

dykes radiate from the lake, cutting through the older lavas as exposed on the inner slope. The inner slope appears to have been formed by fracture, and not by flow. The old crater did not occupy the whole extent of the present caldera; if it had done so the lava would have overflowed at the lowest part of the rim, but the whole rim is formed of lava-flows from some higher and now vanished centre. One very remarkable feature of the geology is the strong glaciation of the rim, shown by well-marked striæ and great morainic deposits. There are traces of glaciers radiating down the slope, in some cases to a distance of five miles. There is evidence of volcanic activity during the glacial period; on one of the peaks of the rim an ice-planed surface of old lava is covered by two layers of pumice separated by a flow of rhyolite. The severe floods, which must have accompanied eruptions at that period, would account for the vast masses of sediments which fill the radiating valleys. The observed phenomena can only be accounted for by the presence of a great volcanic peak covering the present area of the lake, and sweeping upward as a continuation of the present outer slopes. The probable history of this mountain is summarised thus:—

The history of Crater Lake and its rim began in the upbuilding, by normal volcanic processes, of a large volcano—to which the name Mount Mazama is given—comparable in the nature of its lavas and in its structure and size with the greater peaks of the Cascade Range. This volcano was active in the

FIG. 2.—Crater Lake, showing Wizard Island.

glacial period, lava and glaciers combining to mould its form. Somewhere near its final eruption, and perhaps in consequence of the rapid draining away of lava by the small cones near the base of the mountain, the molten material from the interior was withdrawn, the summit of Mount Mazama collapsed and sank away, leaving a huge gulf measuring six miles by four, and about 4000 feet deep. Volcanic activity continued on the floor of the caldera for some time; but since rainfall is in excess of evaporation in that region, water gradually accumulated to form the present Crater Lake.

The water of the lake is remarkably transparent, free from any visible organic matter, and fresh to the taste, but no analysis of its saline contents seems to have been made. The temperature of the water when examined in August 1896, averaged about 60° F. on the surface. The deep-temperature, taken by means of a Negretti and Zambra reversing thermometer in the unsatisfactory Magnaghi frame, was reported as 39° at 555 feet, 41° at 1040 feet, and 46° at 1623 feet. If these figures were trustworthy, it would appear that the water in Crater Lake still derives heat from the rocks; but if this interpretation is correct, it is difficult to account for the minimum at the maximum density point, unless indeed the water is saline enough to have a maximum density point perceptibly lower than that of fresh water. Dr. Evermann, of the U.S. Fish Commission, who made the observations, does not seem to have entire confidence in their accuracy.

Only three species of invertebrates were found living within the rim of Crater Lake—a frog, a snake, and a salamander. By the use of tow-nets several minute algæ were found in the water, and many minute crustacea, of which *Daphnis pulex pulicaria* was the commonest. Several larval insects, a leech, a species of *Gordius*, and one species of mollusc, an undetermined *Physa*, were also found. No fish could be discovered, but an attempt to introduce trout is to be made.

Dr. Merriam gives an elaborate classification of the life-zones on Mount Mazama, and a complete list of all the animals found; an extensive flora is also published, and in all respects the special number of *Mazama* is highly creditable to the Society which has produced it. The Mazamas are to popularise the lake for the use of tourists by introducing various attractions, which we fear will detract from its present charm by destroying the absolute wildness of the whole surroundings. H. R. M.

ADDRESS TO THE ROYAL ASTRONOMICAL SOCIETY.[1]

IT is the duty of your President at this annual meeting of our Society to address you on a very important subject. I allude, of course, to the award of the Gold Medal which is annually conferred by the Royal Astronomical Society on some astronomer who has rendered signal service to our science. The discharge of that duty is, perhaps, the most responsible official act which devolves on the occupant of this chair during his tenure of the distinguished position of President. I am to set forth the ground upon which on the present occasion the medal has been awarded by your Council to our distinguished Fellow, Mr. W. F. Denning.

The contributions of Mr. Denning to astronomy may be ranged under three heads.

(1) Discovery of Comets.

(2) Observation of Planetary Phenomena.

(3) Researches on Meteors.

It will be convenient for me to describe his work in these three different departments in the order just given. The first and second departments must, however, be treated with comparative brevity, for it is on the third department that your Council laid special stress in making their award.

(1) COMETS.

Each year usually brings the announcement of certain new comets, the discovery of such objects being the rewards of those observers who patiently scan the heavens, evening after evening and morning after morning, with the particular object of detecting these shy visitors to our skies. Mr. Denning has been one of those who have engaged in this work, and his success has been noteworthy. The following list gives the designations of five comets which have been discovered by our medallist.

Comet 1881 V. Period, 8·68 years.
Comet 1890 VI.
Comet 1891 I.
Comet 1892 II.
Comet 1894 I. Period, 7·3 years.

While searching the skies for comets, Mr. Denning has not unfrequently discovered nebulæ which had escaped the attention of previous observers. No fewer than twenty new nebulæ have thus been added by Mr. Denning to the lists of those already known. Most of these new objects lie in the vicinity of the North Pole.

(2) PLANETARY OBSERVATIONS.

A striking characteristic of Mr. Denning's work is the methodical accuracy with which he has carried through whatever astronomical research he has in hand. Mr. Denning never spared himself any pains in the efforts necessary to give his work the inestimable charms of thoroughness and precision. This may well be illustrated by his planetary observations. We here

[1] Delivered on February 11 by the President, Sir Robert Ball, on the occasion of the presentation of the Gold Medal to Mr. W. F. Denning.

specially refer to his work on Jupiter. It is well known that this very difficult object not only demands instruments of much optical perfection, but also calls for the exercise of the highest qualities which constitute a consummate astronomical observer. Mr. Denning, using a $10\frac{1}{4}$-inch reflector by Browning, made admirable sketches of the planet, in which he represented a remarkable amount of detail with a skilful pencil. But he was not content with work of this kind merely, however valuable such work may be. He watched the revolutions of a large number of spots individually, and determined as accurately as possible their times of transit over the central meridian of the planet. By such observations he ascertained the period of rotation of a large number of the most notable spots. Thus he illustrated the very interesting fact that the individual spots were animated by large proper motions on the surface of the planet. The famous red spot, so well known to every astronomer, has been in particular most diligently followed by Mr. Denning, and he has demonstrated the remarkable circumstance that its period of rotation varies from year to year. The results at which he has thus arrived are in close accordance with the observations of other accomplished astronomers.

(3) RESEARCHES ON METEORS.

But the great work of Mr. Denning's scientific career, and that which has been mainly instrumental in deciding your Council to confer on him the distinction of the Gold Medal, has been connected with the very interesting subject of luminous meteors. The labours of Mr. Denning have been extensive enough to cover nearly every branch of the subject of meteoric astronomy. It would be difficult, indeed I may say it would be impossible, to render any adequate account of it within the limits of an address. I am, therefore, obliged to restrict myself to those more salient points which have specially been under the consideration of your Council.

The papers on luminous meteors communicated to the Royal Astronomical Society by Mr. Denning, and printed in the *Monthly Notices*, number altogether forty-two. In bulk they would, if collected together, constitute two-thirds of an ordinary annual volume in that form of the Society's publications. These papers are illustrated much more copiously than has usually been the custom with graphic and instructive figures.

A considerable number of these memoirs contain valuable lists of meteoric radiants derived either exclusively from Mr. Denning's own work at Bristol, or from his own observations in comparison with the work of other astronomers in the same field.

Mr. Denning's first published list of radiants appeared in 1876. It contains the determinations of twenty-seven radiant points, derived from his own observations of nearly 900 meteor tracks which he had himself mapped at Bristol between 1871–76. In this early list the periods of the recurrence of the showers are occasionally indicated by single days or short periods. But usually the month of recurrence is alone given. The list contains careful determinations of the radiant-points of the chief annual showers, such as Quarantids in 1873, the Lyrids in 1873 and 1874, the Perseids in 1871 and 1874, the Orionids in 1874, and the Andromedids in 1872. It is interesting to note that showers were found in correspondence with all but four radiants in the list contained in Mr. Greg's first general Star Shower Catalogue. This was published in comparison with Dr. Heis' similar list of the same year in the British Association volume of Reports for the year 1874. The four radiants which Mr. Denning was not able to corroborate are, it ought to be observed, marked as doubtful by Mr. Greg.

The latest list of radiants which has been issued by Mr. Denning, and the longest paper that he has as yet commmunicated to the *Monthly Notices*, was published in 1890. This important work gives remarkable evidence of the unflagging dilligence of our medallist. It contains a list of nine hundred and eighteen radiant points, deduced from the observations of no fewer than 9177 meteors, mapped at Bristol, between the years 1873 and 1889. This list, it should be remarked, includes repeated observations of the same radiants. This is the case not only with regard to the chief showers, but also with regard to various minor showers, whose yearly dates of recurrence cannot in the present state of our knowledge be assigned with any certainty.

Though many of these showers are but sparsely characterised by meteors, or, to use the more technical expression, are showers of great tenuity, they have not escaped the diligent scrutiny of our medallist. In such cases the dates are generally assigned to the single days when they have had apparently a maximum abundance. A column of supplementary dates have been added, which seldom range over more than a week. It will thus be seen that this catalogue presents an extensive series, not so much of averaged results as of exact and valuable individual determinations.

In other papers by Mr. Denning, mean results have been given which may be regarded as expressing, with regard to many important showers, the present state of our knowledge. For the chief meteoric showers a list of this kind was published in 1887. In it will be found mean positions for 1880, derived from fifteen years of observations of the radiant-points of the nine chief yearly showers. These contain the seven well-known periodic swarms of January, April, August, October, November (two showers) and December, adding to these the striking and very regularly visible displays of May 6 and July 28.

The most important contributions which our medallist has made to the general problems connected with luminous meteors are connected with the long duration of certain meteoric radiants. The fact of long persistency of radiant-points, and of close assemblages about the points of groups or compact families of simultaneous or successive meteor streams, is as old as Heis' first essays in meteor showers. It is, however, to Mr. Denning's persistent inquiries that we are mainly indebted for our knowledge of this subject. In his important paper of December 1884, Mr. Denning writes: "The fact of stationary radiants exhibiting visible activity during several months is a phenomenon so unaccountable and so utterly opposed to the approved theories as to the orbits of shooting stars, that it must receive a most crucial examination before it can be accepted."

The long-continued labours of Mr. Denning on this important subject have demonstrated the existence of these enduring radiants. The theoretical difficulties connected with the subject may be still not altogether removed, but we can hardly refuse assent to Mr. Denning's words when he says: "It must be conceived that a well-attested fact of observation, however hard to reconcile with known theories, ought on no account to be disregarded on account of its nonconformity."

It is, of course, known that the Perseids from the August shower are found, not only on the special nights with which the swarm is chiefly associated, but they are also displayed on many preceding and following nights. Mr. Denning has traced meteors of this group for the twenty-six nights from July 25 to August 19, and their radiant advanced in that interval over a distance of 40 degrees. In one of those admirable diagrams by which the interest of Mr. Denning's papers is so greatly increased, he gives a curve of the ordinary number of Perseids from one on July 25 to a maximum of 57 on August 10, and then declining to 1 on August 19. In his paper of 1890 Mr. Denning shows that the range of the Perseids is even wider still. I cite this case of the Perseids, because the gradual shift of the radiants as days and weeks passed by is, of course, no more than should be expected from the change of the place of the earth in its orbit. The extraordinary fact is that in the case of certain other showers, which are visible for weeks or months, the radiant undergoes no appreciable change in position. Mr. Denning selected for discussion in his "Memoir" of 1884 six special showers. Among these we may particularly note the α-β Perseids, which show a constant radiant from July 6 to November 30.

Such a paper as that to which I am now referring must be regarded as a classic which every one who is interested in the fascinating subject of meteors would do well to study. It is full of interesting facts and suggestions. We learn that in the catalogues published up to this date there are no fewer than 2100 radiants resulting from the projected paths of upwards of 6200 meteors; many of these are, however, duplicate observations of identical showers, and Mr. Denning adds that he does not believe the total number of well-defined streams would exceed 350.

In his introduction to the great catalogue of 1890, Mr. Denning has given a statement of his methods of work.

"My plan of work may be briefly described as follows. All the observations were made in the open air and from the garden adjoining the house. Attention was almost invariably given to the eastern sky. In mild weather I sat in a chair with the back inclined at a suitable angle, but on cold frosty nights I found it expedient to maintain a standing posture and some-

times to pace to and fro, always, however, keeping the eyes directed towards the firmament in quest of meteors."

Our medallist has recently published in the *Observatory* an instructive and opportune series of papers on the great showers of Leonids which may reasonably be expected in the next year or two. This subject is here discussed with characteristic wealth of knowledge and experience. He commences with the remark: "It may be safely said that in the month of November during the next few years, all astronomers and a large majority of the general public will become meteoric observers, for the phenomena presented will be of an exceptional kind and of a character to interest every one."

We all echo these words. I think I am justified in adding that much of the recently awakened interest in the subject has been due to the worthy example Mr. Denning has himself given us. Which of us would not be proud to emulate his single-hearted and enthusiastic devotion to the discovery of truth in this beautiful department of astronomy?

It is a matter of great regret to every one here assembled that our medallist, whom we greatly wish to honour, is not now present to accept in person our award. We regret this all the more when we learn that ill-health is the cause of his absence. We all join in a hearty wish for his speedy recovery, and in the hope that he may shortly be able to resume those observations which we receive with such interest and pleasure. We desire to assure him not only of our appreciation of his admirable work, but of the high esteem which we entertain for the spirit in which that work has been conducted.

On your behalf, therefore, I now hand the Gold Medal of the Royal Astronomical Society to our Secretary, to be by him transmitted to Mr. W. F. Denning in recognition of the valuable services to our science he has rendered, especially in the department of meteoric astronomy.

HISTORY AND OBJECTS OF THE PHYSICAL SOCIETY.[1]

I PROPOSE on this occasion to begin with a few words on the history and objects of our Society, and afterwards to glance briefly at the principal events of physical interest which have occurred during the past year.

The Physical Society was founded in 1874, and owed its origin mainly to the initiative of the late Prof. Guthrie. From the first years of its existence up to the present time it has included among its members nearly all the leading physicists of the United Kingdom.

In the early days our meetings were, by permission of the Lords of the Committee of Council on Education, held in the Physics lecture-room of the Royal College of Science at three o'clock on Saturday afternoons, members being allowed the free use of the laboratory apparatus for the illustration of their papers. The proceedings were at that time rather less formal than is customary at present. The papers were rarely, if ever, "referred" before being read; often, indeed, they were read long before they were actually written, while a large proportion of the communications were of a purely oral character, and never intended for publication at all, except perhaps in the short notes which the reporter sent to the scientific journals. Special prominence was given to experimental demonstrations illustrative not only of original researches, but also of such work carried on outside the Society as happened to be attracting attention at the time. . . .

Under the somewhat lax *régime* which then prevailed, it necessarily happened that the communications made to the Society were not always of a very high order of merit. . . . But from the very beginning the Council has always been careful not to print in the *Proceedings* anything that was not of sound scientific value, and while the number of important papers that have been published through the medium of the Physical Society is large, very little of doubtful quality has found a place in the *Journal*.

The first material change in our routine took place in the year 1889, when the day and hour of meeting were altered from Saturday afternoon at three to Friday at five o'clock. . . . I may here mention that the Council has more than once considered whether it might not be expedient to hold our meetings in the evening. Many, no doubt, would consider this preferable, but the balance of convenience appears to be clearly in favour of the afternoon. . . .

During the South Kensington epoch the Physical Society published and presented to its members a number of valuable books, including, among others, Prof. Everett's well-known treatise on the C.G.S. system of units and the works of Wheatstone and of Joule. It also issued twelve volumes of *Proceedings*, in which were collected such of the communications to the Society as had been approved for publication. By an arrangement with the proprietors of the *Philosophical Magazine* the same papers were also (as now) printed in that journal, being thus, to the author's great advantage, assured of a wide circulation throughout the scientific world. In the same period, notwithstanding the small amount of the annual subscription paid by members and of the composition fee for life membership, the Society's income so far exceeded its expenditure that it was able to accumulate and invest a capital of nearly 3000*l*.

When the Society entered upon its twenty-first year with a position which, if somewhat unpretending, was well recognised and firmly established, it was felt that the time had come when, in the interests of physical science, something more than had been already achieved might fairly be demanded of it. British physicists had long been at a serious disadvantage in that they were without any means of readily ascertaining what was being done by their fellow-workers in other countries; with the multiplication of scientific literature the need of some periodical digest similar in character to the German *Beiblätter* was becoming year by year more urgent. To endeavour to meet this want was a duty which clearly devolved upon the Physical Society, and the Council anxiously considered the question whether the publication of monthly abstracts of physical papers appearing in foreign journals could be undertaken by ourselves.

The only serious objection to the enterprise was of a financial nature. The work, if it were to be carried out efficiently, would certainly necessitate an annual expenditure exceeding by some hundreds of pounds the total income of the Society. This could only be met by raising the amount of the annual subscription and composition fee, which, as I have mentioned, were unusually low. But it is a delicate and difficult matter to ask existing members of a society for increased subscriptions unless very excellent reasons can be shown for the demand. The Council therefore determined that they would publish a series of abstracts for one year at least before taking any steps to provide additional income, defraying the cost from cash in hand and, if need should arise, drawing upon the invested capital. In this way it was hoped to convince members of the utility of the undertaking which they were to be called upon to support.

I need not remind you of the highly satisfactory result of the experiment. The work of the able and assiduous body of abstractors whose names appear on the cover of our *Proceedings* was on all sides cordially approved, and at a special general meeting, held in 1896, a resolution submitted to the Society for increasing the subscription to two guineas per annum was passed almost, if not quite, unanimously. The number of those who in consequence of this increase have resigned their membership has been unexpectedly small, while on the other hand many of the life members have, in response to the invitation issued to them, voluntarily contributed an additional fifteen guineas to the funds of the Society, in recognition of the fact that they are now in enjoyment of greater and more costly advantages than were contemplated at the time when they paid their very moderate composition fees. To such as have not yet responded I venture to repeat the invitation.

Although the abstracts were actually published for two years before the increased subscriptions began to come in, the whole cost was met out of uninvested cash, supplemented by grants liberally made by the British Association and the Royal Society, and it was never found necessary to draw anything at all from the reserve fund. I wish to emphasise this fact because the abundant caution properly exercised by the Council in entering upon a new and uncertain enterprise appears to have led to a very general impression that the Society had outrun its means and was on the verge of bankruptcy, whereas in truth it was never in a more prosperous financial condition than it is at present.

On October 26, 1894, the Society met for the first time in this room. Although the privileges so generously accorded to us by the authorities at South Kensington were highly valued, it was nevertheless deemed advisable that we should leave the home of our youth and seek a footing in Burlington House, the

[1] Presidential Address to the Physical Society. (Abstract.) February 11. By Shelford Bidwell, F.R.S.

headquarters of scientific associations. Here the Chemical Society offered us a most kindly and cordial welcome, and provided us with a meeting-place which is not only more generally accessible than the old one, but is also on other grounds more convenient to most of our Fellows.

By this time the general affairs of the Society had assumed a more business-like condition. Amongst other things, greater care was exercised with regard to the acceptance of communications. I need hardly say that no paper is in these days allowed to be read unless it has been first referred to some competent authority and favourably reported on. The most distinguished physicists in the kingdom have given their services as referees, and our heartiest thanks are due to them for the care and patience which they have ungrudgingly bestowed upon a somewhat ungrateful task.

The practice was also introduced of putting the more important papers into type before they were read, and distributing proofs among such of the Fellows as were known to be specially interested in the subjects to which they related. This course has led to a considerable improvement in the value of the discussions.

The most recent step in advance consists in the adoption of a scheme for greatly extending the list of journals from which the monthly abstracts are made. Hitherto the papers abstracted have been exclusively such as had been published in foreign journals, and were of primarily scientific interest. In the present year, as the result of an agreement with the Institution of Electrical Engineers, the number of the abstracts is to be largely increased, British publications and papers of a technical character being included in their scope. The arrangement in question is open to the objection that it entails the loss of our monopoly in the publication, for members of the Institution of Electrical Engineers will, like ourselves, receive copies of the abstracts, and will share with us whatever credit attaches to their production. The objection, however, appears to be in the main only a sentimental one, and of small weight in relation to the substantial advantage accruing to our members—an advantage which could not possibly have been provided out of our own unaided resources. [Reference was then made to the advantages afforded by the Physical and other kindred Societies in promoting friendly intercourse among fellow-workers in a particular branch of science.]

Through the kindness of certain influential gentlemen belonging to the Society, we have from time to time been afforded the opportunity of holding a meeting in some well-known physical laboratory either in town or in the country. I myself have had the privilege of taking part in most agreeable pilgrimages to Oxford, Cambridge and Bristol, and have also been among those who enjoyed the hospitality of Profs. Adams, Carey Foster, Ayrton and Thompson at their laboratories in London. I have pleasure in announcing that the Council has accepted an invitation from our Fellow, Mr. Porter, to go to Eton for the next meeting on February 26, and I trust that our appreciation of his kindness will be testified by a large gathering. It is a little difficult to beg for favours, but I may be allowed to suggest to those who are in a position to exercise similar hospitality, that they have it in their power to contribute, in a material degree, and in more than a merely scientific sense, to the well-being of the Society.

[The second part of the address dealt with the discovery of the Zeeman effect; some of the principal papers published by the Physical Society in 1897; the appointment of the National Physical Laboratory Committee, and the foundation of the Röntgen Society.]

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE annual general meeting of the Institution of Mechanical Engineers was held in the theatre of the Institution of Civil Engineers on the evenings of the 10th and 11th insts. The usual formal proceedings having been gone through, the retiring President—Mr. E. Windsor Richards—introduced the new President, Mr. Samuel W. Johnson, who is locomotive superintendent to the Midland Railway. There were two papers down for discussion, and there was also an adjourned discussion on a paper entitled "Mechanical Features of Electric Traction," which had been read and partially discussed at the last meeting of the Institution. This paper was contributed by Mr. Philip Dawson, who is largely interested in the introduction of mechanical appliances in connection with electrical engineering into this country from America. Under these circumstances it was natural that the contribution should be of a general rather than a scientific character. The prominent feature in the paper was the fact that electrical traction has spread so rapidly in America, whilst very little has been done in this country. For instance, out of a total of nearly 15,000 miles of tramways in America in the year 1895, 12,583 miles are worked electrically. Cable traction, which was at one time so popular, and which seemed to have so promising a future before it, has been quite eclipsed by electrical methods, there being only 600 miles of rope tramway in the States in the same year. Steam has even a lower total, there being but 519 miles. Horse traction supplies the balance of something over 1200 miles. Great Britain and the Colonies in the year 1896 had but 167 miles of electric tramway, thus being far below Germany, which had a total of 618 miles. The only other European country having more than 100 miles was Austro-Hungary, with a total of 120 miles. Belgium had 90 miles, France 67, Italy 50, and Switzerland and Russia 30 miles each; whilst other European countries contribute 30 miles altogether.

It is not necessary we should follow the author in the practical details he gives regarding the various features of motors, trucks, cars, permanent way, conductors, methods of transmission, generating stations, &c. The long discussion on this paper resolved itself very largely into a controversy as to whether English engineers should follow American precedents. Prof. Unwin, in the speech that he made, entered a timely protest against the spirit of detraction which animated a good many of the speakers. As he said, American engineers may not be perfect in all their practice, and it is quite possible improvements may be made upon their methods, still they have had considerable experience, and what they have done represents actual work, whilst in this country we have practically no precedents in regard to electrical tramway practice.

The only paper read at the meeting was a contribution by Prof. Frederic W. Burstall; it embodied the first report of the Gas Engine Research Committee that had been appointed by the Institution, and of which Prof. Alexander Kennedy is the chairman. The object of the experiments described was to determine the effect produced on the economy of gas engines by altering one or more of the conditions which govern their working. The problem is one of a complex nature and presents considerable difficulties, especially as the gas engine has not like the steam engine been made the object of investigation by many authorities for a great number of years. The factors considered by the Committee were the amount of compression, the speed, the ratio of air to gas, and the amount of heat rejected through the walls of the cylinder. The engine used was of small size, perhaps too small to afford altogether satisfactory results; but the Committee were not to blame for this, for they had to work with such tools as they could command. The nominal power of the engine was 2 N.H.P., and the maximum that could be developed was 5 I.H.P; it was made by Messrs. Fielding and Platt, of Gloucester. The author stated that an increase of compression in a gas engine is often regarded as being conducive to more economical results, but it is uncertain whether the increase in economy is really due to the compression alone. It is, perhaps, fair to state that the Committee recognised that the absolute economy of the engine tried—which was specially constructed for experimental purposes—would be inferior to the economy that could be obtained by a larger motor; still, it was concluded that the comparative economies under different conditions would not be different in the two sizes; moreover, it was stated that it would have been impossible to measure with precision certain quantities, such as the volume of air, had the engine been larger. The compression employed in the experiments varied between 35 lbs. and 90 lbs. per square inch. The observations taken included measurements of the gas and of the air supplies, measurement of heat rejected into the jacket, sampling of exhaust gases, and determination of the I.H.P. developed. Seventeen tests were taken, and the mechanical efficiency of the engine was found to vary from 76 to 84 per cent., the mean value of the whole seventeen tests being 81 per cent. On a full power test the engine was running at 197 revolutions per minute, the compression per square inch absolute was 103 lbs., the ratio of clearance to cylinder volume was 0·25, and the ratio of explosions to the maximum possible was 92 per cent. Under these circumstances the

I.H.P. was 5·10, the gas per I.H.P. per hour 20·35 cubic feet, the heat expended per I.H.P. per hour was 12,186 thermal units, or 10·95 thermal units per explosion. The thermal efficiency was 21 per cent. Taking one of the low-speed experiments, with the ratio of air to gas of 10·4, the compression per square inch absolute was 86 lbs., the ratio of clearance to cylinder volume was 0·37, the revolutions per minute were 117·6, and the ratio of actual explosions to the maximum possible was 75 per cent. With these conditions the I.H.P. was 1·84, the gas used per I.H.P. per hour 28·2 cubic feet, the heat expended was 17,041 thermal units per I.H.P. per hour; that gave a thermal efficiency of 15 per cent., a result which, as the author remarks, was distinctly uneconomical. In the following test the compression was 102 lbs. absolute, the ratio of clearance to cylinder volume being 0·25, the revolutions and the I.H.P. were practically the same, but 31 cubic feet of gas were used per I.H.P. per hour; the thermal efficiency, therefore, being 13·6 per cent, although the compression was so much higher than in the previous test mentioned, almost approaching that of the full-speed test first referred to.

In connection with this matter, the fact commented upon during the discussion may be referred to. The older gas engines were designed for lower pressures; and it is found with them that increasing the compression does not add to economy. The ratio of clearance has an important bearing on the case, the port surface acting as a condenser, and an increase in the compression induces a degree of cooling which is not economical. There is also the loss by leakage through the indicator, the proportion of which will be considerable in the case of a small engine. The Wayne indicator used during the experiments has a rotating piston not touching the sides of the cylinder, and therefore admitting of constant leakage. In the steam engine the loss from leakage through the indicator is comparatively unimportant, being governed by the pressure present in the cylinder at any given time. With the gas engine, however, this is different, as the working mixture escapes through the cylinder before ignition. One of the speakers humorously likened the effect of an indicator on a small gas engine to a big whistle on a steam launch boiler. He said that in the early days of steam launches a friend of his had a small paddle yacht with a very big whistle, which was fitted in order that he might let his friends know when he was coming. He found, however, that when he paddled he could not whistle, and when he whistled he could not paddle.

A brake was used in the experiments, and perhaps it would have been better if Brake H.P. had been given in the tables. It was found that the measurement of gas by means of an ordinary meter, although giving a correct aggregate result, possessed the disadvantage of not controlling the fluctuations of pressure in the mains; a calibrated gas-holder was therefore used. The amount of air used per stroke was measured by a meter into which air was forced by a Sturtevant blower, the pressure being kept constant by means of a gas governor; precautions were taken to prevent back ignition; a rubber gas bag was used to obviate the fluctuation in pressure in the meter during the suction stroke. No difficulty was found in working this apparatus. Records were taken of pressure and temperature of the air; measurement of the heat rejected was effected by running the cooling water from the calibrated tank through the water jacket and thence to the discharge, the capacity of the tank being sufficient to hold water for a single test. The temperatures of the inlet and outlet water were taken. The glass stems of the thermometers were attached to brass plugs by means of soldering with Thomas's fusible metal, which enables glass and brass to be fixed together with a pressure-tight joint. To obtain samples of the exhaust gases, a single bubble of gas was taken from just below the exhaust-valve after each explosion stroke by means of suitable apparatus, which was illustrated by a wall diagram shown during the reading of the paper. The Wayne indicator used to find the I.H.P. was considered superior to the Richards, Crosby, Darke or Tabor indicators. It was made by Messrs. Elliot Brothers. This indicator appears to be similar in principle to one introduced by Mr. Michael Longridge some years ago. For reducing pencil friction to a minimum, cards of smoked mica were introduced in place of the usual paper. An iron tube was used for ignition, electrical methods having been tried, but were not found satisfactory.

The author, in giving a summary of the experiments, concluded that it was probable that the influence of increased compression on economy was due to the fact that weaker charges can be burnt completely during the stroke when the compression is high. It should be stated that in the test of which we have given particulars, in which the thermal efficiency was 21 per cent., the author considered that more economical results than this could be obtained, as the ratio of air to gas was 8·6, which was certainly higher than necessary. It may be added that the best mixture for a modern gas engine is considered to be one of gas to ten of air by volume. The report continued that the test seemed to indicate that economy depends on the choice of the correct ratio of air to gas, and that this ratio increases with compression. The number of experiments was not yet sufficient to determine what any ratio was for any given compression, but it is stated that further tests are to be made for arriving at this important point.

The summer meeting of the Institution will be held this year in Derby.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. Charles Godfrey, of Trinity College, has been elected to the Isaac Newton Studentship in Physical Astronomy.

The General Board of Studies propose that the Professorship of Surgery, held by the late Sir George Humphry, be suspended until the Senate shall otherwise determine. Meanwhile the duties of the office are to be discharged by a Reader in Surgery, at a stipend of 240*l.* a year.

The General Board also propose to recognise the continued liberality of the Royal Geographical Society in providing for the endowment of geographical teaching, and the importance of encouraging the study of the subject in the University by raising the present Lectureship, held by Mr. Yule Oldham, to a Readership in Geography, with a total stipend of 200*l.* a year.

DR. KARL HÜRTHLE, assistant professor of physiology at Breslau, has been appointed professor of physiology and director of the Physiological Institute, in succession to the late Prof. Heidenhain.

THE Council of King's College, London, have received from the Trustees of the British Museum a valuable series of fossils, in aid of the teaching collection for the Geological Laboratory in the Science and Engineering Faculty.

AN anonymous donor has offered 10,000*l.* for the completion of the extension scheme of Aberdeen University, on the condition that 20,000*l.* is obtained from the Government for the same object. The Chancellor of the Exchequer has agreed to receive a deputation on behalf of the movement for the extension of the University.

Science states that at the semi-annual meeting of the Board of Trustees of Beloit College it was announced that the College had received a gift of 25,000 dollars for the endowment of the chair of Chemistry, now occupied by Prof. E. G. Smith. The donor wishes to remain anonymous. It was also reported that the sum of 70,000 dollars had been raised towards the 100,000 dollars necessary to secure Dr. Pearson's gift of 50,000 dollars.

THE rapid progress of medical education and the enlargement of the requirements of the Examining Boards have rendered it imperative to provide more space for the teaching of several important subjects in the London Hospital Medical College. Consequently a large portion of the College is about to be rebuilt and enlarged, and all the necessary class-rooms and laboratories provided. It is intended that the work will be completed by the commencement of next winter session.

THE magnitude of the operations of the Department of Science and Art may be judged from the figures given in the Calendar of the Department for 1898. The total number of individual students in science classes held under the auspices of the Department was 157,984. The subjects which attracted more than ten thousand students in the year covered by the Calendar are: Mathematics (Stages 1, 2, 3), 40,244; Inorganic Chemistry (Theoretical), 26,433; Practical Plane and Solid Geometry, 24,069; Physiography, 22,409; Machine Construction and Drawing, 19,952; Building Construction, 15,195; Magnetism and Electricity, 12,591; Hygiene, 10,143. At the other end of the scale we find that mineralogy only attracted 152 students, and zoology 189. Nine of the depart-

mental subjects are practical; and the number of students who took practical work is as follows: Inorganic Chemistry, 15,169; Magnetism and Electricity, 2694; Sound, Light, and Heat, 1793; Organic Chemistry, 1538. The remaining practical subjects—human physiology, general biology, zoology, botany, and metallurgy—divided 1852 students between them. There are now 169 Schools of Science in which organised courses of study are taken in connection with the Department, and the number of students attending them is 20,879.

SCIENTIFIC SERIALS.

THE most important contribution to *Himmel und Erde* for this month is a long paper on the terminal moraines of North Germany. The other papers comprise one in which is given the conclusion of a lecture by Dr. Drygalski on Greenland, dealing mainly, in this part, with the habits and customs of the Esquimaux; and another by Herr G. von Gleicke treating of the existence of an intra-mercurial planet or planets, generally surveying the various theories that have been put forward to explain the motion of the perihelion of Mercury. The only result that appears certain in the paper is the practical confirmation of the reality of the motion, originally determined by Le Verrier. The presence of a single planet or of a ring of meteoric matter; the existence of an unknown satellite of the planet itself, or an ellipticity in the figure of the sun; an alteration in the expression of the law of gravitation or the introduction of terms suggested by electrodynamic considerations; all seem to offer insuperable objections, or to be based on pure empiricism. The enigma is not solved yet. The subjects to which the shorter notes refer have generally been mentioned in these columns. They include some account of the Greenland Meteor; the sinking of the surface of the earth in the neighbourhood of the Canadian lakes, and its effect on the Niagara Falls; the depth of the sea and the determination of ocean currents around Australia derived from floating bottles. A short notice is also added of a proposed attempt on the part of MM. Godard and Surcouf to reach the North Pole by means of ballooning. The expedition would start in the summer of 1898, selecting Spitsbergen as a base of operations. The peculiar feature of the attempt seems to consist in carrying twelve small balloons, filled with hydrogen to serve as a gasometer to supply the main balloon, which is of gigantic dimensions, with the gas which may leak or waste. M. Godard counts on spending sixty days aloft, and to carry with him the means of support of no less than seven people, among whom will be found a chemist, a meteorologist, and a physician.

Memoirs of the Caucasian Branch of the Russian Geographical Society, vol. xviii.—On the distribution of precipitation in Caucasia during the spring and summer of 1894, by A. Woznesensky, with four maps.—Journey in the Chernomorsk district, in 1894, by N. Alboff; with a map (on the scale of seven miles to an inch) of the Chernomorsk district and the western part of the district of Sukhum; and botanico-geographical researches in Western Transcaucasia, by the same author, being a continuation of his paper inserted in a preceding volume of his *Memoirs*. In this paper two important excursions across the main ridge of Abhasia are described. The flora of the limestone-mountains having been the special subject of studies, it is dealt with in detail. The rare new species *Amphoricarpus elegans*, which was formerly found at two places only of Abhasia and Mingrelia, was met with in thousands. A bush-like *Campanula*, which M. Alboff considers as a new species, was found and was named *C. regina* for its rare beauty. Numbers of other rare species were found. Detailed lists of the limestones' fauna in Abhasia and Mingrelia are given. In addition to the glaciers previously discovered on the northern slope, a hanging glacier was found on the southern slope. Very interesting remains of the ancient population of the region are mentioned.—On the Kumyks, anthropological sketch by J. Pantukhoff. The paper contains a sketch dealing with the possible origin of this Tartar stem, anthropological measurements made by the author, and a comparison of the same with measurements on other Caucasian stems.—The Pshaves and their land, by D. Khizanachwili.—A journey in the central portion of the Mountain-Chechnya, by Madame A. Rossikoff, with a map three and a half miles to the inch. Detailed and lively account of a journey in that imperfectly known part of Daghestan, the seat of Shamil's wars.—Statistical description of, and statistical data relative to, the provinces of Baku, Kars, Erivan, Daghestan, and Elisabethpol.—On the condition of glaciers and of the lakes on the northern slope of Central Caucasus, by K. Rossikoff.—In a very interesting appendix we find (1) a beautiful atlas of eight ethnographical maps of Transcaucasia, one for each separate province, on the scale of thirteen miles to an inch (it is the work of E. Kondratenko); (2) a map of the distribution of the Armenian population in Asia Minor, on the basis of V. Cuinet's data, 1890-94, accompanied by a paper by General Zelenyi and Colonel Sysoeff; and (3) the distribution of Armenian populations in Transcaucasia.

WE have received the number of the *Irish Naturalist* for February, and are always glad to say a word on behalf of these local natural history journals, which have done so much to encourage the early enthusiasm of many who have afterwards become eminent naturalists. In the present number Mr. Allan P. Swan describes and figures a new species of *Leptolegnia*, *L. bandoniensis*, belonging to the *Saprolegniaceæ*.

THE *Journal of Botany*, in its numbers for January and February, still continues to cater chiefly for descriptive and "critical" botanists. Mr. F. Townsend describes and figures a new species of *Euphrasia*, *E. canadensis*, from the neighbourhood of Quebec; and Miss Ella M. Tindall enriches British Hepaticæ with a species new to science, *Fossombronia Mittenii*, from North Devon, which is also figured

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 20.—"Fergusonite, an Endothermic Mineral." By William Ramsay, Ph.D., LL.D., Sc.D., F.R.S., and Morris W. Travers, B.Sc.

The mineral fergusonite, discovered by Hartwall, occurs in felspar and mica deposits, in the same manner as most of the rare Norwegian minerals, such as euxenite, orthite, samarskite, &c. The position in which such minerals are found, embedded in masses of felspar, or encrusted with mica, leaves the question of their origin an open one. Whether they are deposited in the felspar by water, or whether they are contemporaneous with the felspar, is a matter of speculation. Fergusonite is a black lustrous mineral, not unlike obsidian in outward appearance, but of considerably higher density. Seen under the microscope, even with the highest power, there is absolutely no sign of crystalline structure, though in thin slices the substance is translucent, and transmits yellow-brown light. It is, however, macrocrystalline, occurring in quadratic sphenoids. It is quite homogeneous, and displays no sign of cavities. Like similar minerals, it contains helium, which is expelled on the application of heat.

But this mineral presents a peculiarity, which has led us to publish this note. When heated to a temperature not exceeding 500° or 600°, it suddenly becomes incandescent, and evolves much of its helium; while its density decreases.

The analysis of the mineral was kindly undertaken by Miss Emily Aston, to whom we desire to express our indebtedness.

It showed that fergusonite is mainly a niobate of yttrium, containing oxides of uranium, but in no great quantity.

The gases evolved by the incandescence of nearly 5 grams (4·852) of the mineral, heated in a vacuous tube, were analysed and found to consist of helium, hydrogen, carbon dioxide, and nitrogen.

The density was determined before and after heating. Great care was taken to make sure of the absence of air-bells, by warming the powdered mineral under water in a vacuum, before weighing it.

Density before heating	5·619
,, after ,, ...	5·375

It is thus seen that the mineral loses density on incandescence.

The amount of heat lost by this curious mineral in parting with its helium was determined. The plan of operation was to burn in oxygen a known weight of hydrogen, ascertained by measuring it, under a small platinum crucible, in a calorimeter. The rise of temperature was noted. This operation was repeated several times, so as to standardise the calorimeter. Some grams of mineral were then placed in the crucible, and the operation was repeated; the heat evolved by the incandescing mineral added itself to that from the burning hydrogen, and the

rise of temperature was greater. Knowing the heat of combustion of hydrogen, a simple calculation gave the heat evolved by the exothermic change in the mineral.

Various questions are raised by the behaviour of this interesting mineral. Its evolution of heat, accompanying its parting with helium, suggest the idea that it is a true endothermic compound of helium. Had its density, as is the case with alumina, and with other oxides which rise spontaneously in temperature when heated, increased instead of decreased, the evolution of heat might justly have been ascribed to polymerisation. But an evolution of heat, accompanied by a *fall* in density, leads to the conjecture that the loss of energy is the result of the loss of helium; and that, conversely, the formation of the compound must have been concurrent with a gain of energy. That the helium is actually in combination, and not retained in pores in the mineral, is evinced by there being no pores in which the helium might be imprisoned. Surface-absorption is equally out of the question, for the mineral is compact. The only remaining possibility is that the helium is in chemical combination. And if this is true, then the compound must be an endothermic one.

There is one other substance at least which decreases in density, while it evolves heat; that substance is water, in changing into ice. The effect of compressing ice is to lower its melting point, and at the same time to reduce its heat of fusion. At a sufficiently high pressure there would be a continuous transition from ice to water, no heat change taking place during the transition. Matters would be in a similar condition to those which accompany the change of a liquid into gas at the critical temperature; the smallest alteration of temperature would be enough to bring about the change. In speculating on the origin of such a remarkable compound, is it not allowable to guess that it represents a condition of our earth realised only before solidification had set in? That these minerals, containing the rare elements, represent a portion of the interior of our planet; and that under the enormous pressure obtaining at the centre, combination with helium was an exothermic event; and that such compounds, having by some unexplained accident come to the surface of the globe, where they are no longer exposed to such pressure, they have, in consequence of the change, become endothermic? The frequency of the helium spectrum in the stars, and its presence in the sun, makes it less improbable that some such explanation may lie not far from the truth.

February 3.—"Note on the Experimental Junction of the Vagus Nerve with the Cells of the Superior Cervical Ganglion." By Dr. J. N. Langley, F.R.S., Fellow of Trinity College, Cambridge.

The author concludes from his experiments that there is no essential difference between the efferent "visceral" or "involuntary" nerve fibres, whether they leave the central nervous system by way of the cranial nerves, by way of the sacral nerves, or by way of the spinal nerves to the sympathetic system. All of these fibres he takes to be pre-ganglionic fibres. And he thinks that any pre-ganglionic fibre is capable, in proper conditions, of becoming connected with any nerve-cell with which a pre-ganglionic fibre is normally connected; although apparently this connection does not take place with equal readiness in all cases On the whole it appears that the functions exercised, both by pre-ganglionic and by post-ganglionic fibres, depend less upon physiological differences than upon the connections which they have an opportunity of making during the development of the nervous system and of the other tissues of the body.

Physical Society, Annual General Meeting, February 11, 1898.—Mr. Shelford Bidwell, President, in the chair. The Report of the Council was read by Mr. Elder. Dr. Atkinson then presented the Treasurer's Report, and informed the Society of the improved condition of its finances. The difficulties of the previous year had arisen from the expenses incurred by the publication of abstracts of current scientific literature; those difficulties had been surmounted without drawing upon the reserve fund. Very few Fellows had objected to the increase of subscription. In acknowledgment and appreciation of the abstracts, now presented to all Fellows, many of the original life-members had lately made additional voluntary donations to the funds of the Society, thus sharing with new Fellows the extra outlay involved by the abstracts. It was to be hoped that all life-members would adopt this course, more especially as the scope of scientific literature covered by the abstracts was now being extended to British as well as to foreign sources. Votes of thanks were passed to the Council, the officers, and to the Council of the Chemical Society for the use of their rooms at Burlington House. Two Honorary Fellows were unanimously elected by ballot, *i.e.* Riccardo Felici, professor in the University of Pisa; and Emilio Villari, professor in the University of Naples. Council and officers for the forthcoming year were elected as follows. President: Mr. Shelford Bidwell. Vice-Presidents (who have filled the office of President): Dr. J. H. Gladstone, Prof. G. C. Foster, Prof. W. G. Adams, The Lord Kelvin, Prof. R. B. Clifton, Prof. A. W. Reinold, Prof. W. E. Ayrton, Prof. G. F. Fitzgerald, Prof. A. W. Rücker, Captain W. de W. Abney. Vice-Presidents: Prof. C. Vernon Boys, Major-General E. R. Festing, Mr. G. Griffith, Prof. J. Perry. Secretary: Mr. H. M. Elder, 50 City Road, E.C. Foreign Secretary: Prof. S. P. Thompson. Treasurer: Dr. E. Atkinson. Librarian: Mr. W. Watson. Other Members of Council: Prof. H. E. Armstrong, Mr. Walter Baily, Mr. L. Clark, Dr. A. H. Fison, Mr. R. T. Glazebrook, Prof. A. Gray, Prof. J. Viriamu Jones, Mr. S. Lupton, Prof. G. M. Minchin, Mr. J. Walker.—The President then read an address in which the aims and history of the Physical Society were outlined. (An abstract of this address is published in the present issue, p. 378.) Prof. Rücker said that among the new and useful departures lately made by the Physical Society the institution of a presidential address was particularly worthy of notice; it was very desirable, from time to time, to hear a summary of what had been achieved during the year; it was also desirable that the objects of the Society should be, from time to time, definitely stated; this departure had been fully justified by the address of Mr. Shelford Bidwell.—A paper by Mr. G. H. Bryan on electro-magnetic induction in plane, cylindrical and spherical current sheets, and its representation by moving trails of images, was read by Mr. Elder. The phenomena of induction in a cylindrical conducting sheet in a two-dimensional field, and of induction in a spherical sheet in any field due to the generation or motion of poles, magnets, or currents, in the presence of the sheet, can be represented by moving trails of images which are but slightly more complicated than the well-known trails of images in a plane sheet. The images, representing the potentials of the induced currents on the two sides, start from the source of disturbance and its inverse point, and move normally away from the surface of the sphere and cylinder, with velocity varying directly as the disturbance. At the surface of the sheet this velocity becomes equal to the corresponding velocity for a plane sheet. The images are in most cases similar in nature to the inducing source of disturbance, and their intensities are found, in every case, to vary as a power of the distance from the centre. The images due to the sudden generation of a magnetic pole in the presence of a spherical sheet are, however, analogous to the hydro-dynamical image of a source in a sphere. Dr. S. P. Thompson said the method and the results obtained would find useful application in the solution of many allied problems.—The President proposed a vote of thanks to the author; the meeting was then adjourned until Saturday, February 26, on which occasion the Physical Society will visit Eton College. [Fellows are informed that a train leaves Paddington for Windsor at 2.25 p.m. This arrives in time for the meeting, which is at 4 p.m.]

Zoological Society, February 1.—Dr. St. George Mivart, F.R.S., Vice-President, in the chair.—Mr. Oldfield Thomas exhibited the skull of a giraffe from the Niger region, which had been shot by the late Lieut. R. H. McCorquodale, and presented to the British Museum by his brother, Mr. W. Hume McCorquodale. No giraffes had previously been received from this region, and as the skull proved to differ from that of the typical species in its greater size, longer muzzle, and more divergent horns, it was considered to represent a special subspecies, for which the name of *Giraffa camelopardalis peralta* was suggested.—Mr. Sclater exhibited some photographs of giraffes in order to show the differences in markings between the two forms *Giraffa camelopardalis typica* and *G. c. capensis*.—A letter was read from Mr. J. Graham Kerr, containing notes on the habits of the Paraguayan Lepidosiren, as observed by Mr. R. J. Hunt. It was shown that during the dry season it retired into burrows like its African relative *Protopterus*.—Mr. G. A. Boulenger, F.R.S., gave an account of the fishes collected by Dr. J. Bach in the Rio Jurua, Brazil. Fifty-one species were enumerated, of which nine were described as new.—Mr. F. E. Beddard, F.R.S., read a paper on the anatomy of

an Australian cuckoo, *Scythrops novæ-hollandiæ*, which he was disposed to regard as being more nearly allied to *Eudynamys* than to any other form of the Cuculidæ.—Dr. A. G. Butler read a paper on a collection of Lepidoptera made by Mr. F. V. Kirby, chiefly in Portuguese East Africa. Ninety-two species were enumerated, of which one (*Euralia kirbyi*) was described as new. The paper also contained the description of a new species of *Cyclopides*, viz. *Cyclopides carsoni*, from Fwambo, collected by Mr. A. Carson.—A communication from Dr. N. H. Alcock, on the vascular system of the *Chiroptera*, was read by Prof. Howes. The anatomy of the vascular system of *Pteropus medius* was described and shown in its general plan to resemble in many respects that occurring in the Rodentia, and observations of a comparative nature were added on the pleuræ, pericardium, and lungs. A summary of the literature upon the *Chiroptera* was also included in the paper.

Entomological Society, February 2.—Mr. G. H. Verrall, Vice-President, in the chair.—The Secretary read a letter from Mr. A. D. Michael asking if any entomologists, who might find insects attacked by mites (*Acari*) among their disused boxes, would be willing to send him such insects, with the mites still on them or accompanying them, or at least, the mites themselves, with the name of the insect given in all cases, for the purpose of his forthcoming monograph of the Tyroglyphidæ.—Mr. J. W. Tutt showed a fine series of forms of *Hemerophila abruptaria*, Thunb., captured and bred by Mr. W. S. Pearce at Holloway, varying from the normal colour, through mahogany-brown to dark fuscous, some of the specimens of the second brood showing a purplish hue. One gynandromorphous example was shown, with the wings and right antenna of the female type, the left antenna being strongly pectinated. He also exhibited two specimens of *Dianthœcia luteago*, bred by the Rev. F. Lowe, from larvæ obtained in Guernsey, and of a very distinct character, having a tendency to the ochreous coloration of the type-form, but being differently marked.—On behalf of Mr. Heyne, Mr. Jacoby exhibited a series of temperature-varieties of Lepidoptera.—Mr. G. H. Carpenter read a paper by himself and the Rev. W. F. Johnson on the larva of *Pelophila borealis*, describing its structure and life-history. On the larval characters the species, hitherto considered as of doubtful relationship, was regarded as being closely allied to *Elaphrus*.—Papers were communicated by Mr. F. D. Godman, F.R.S., and Mr. O. Salvin, F.R.S., on new species of American Rhopalocera, and by Mr. M. Jacoby, on some phytophagous Coleoptera (Eumolpidæ) from the Islands of Mauritius and Réunion.

Chemical Society, February 3.—Prof. Dewar, President, in the chair.—The following papers were read:—The volumetric estimation of sodium, by H. J. H. Fenton. Sodium dihydroxytartrate is very sparingly soluble in water at 0° and the solubility in presence of excess of a dihydroxytartrate is practically negligible; since dihydroxytartaric acid is readily oxidised by permanganate in sulphuric acid solution, the formation of the sodium salt affords a simple and accurate method of estimating the metal.—The atomic weight of boron, by F. P. Armitage. From determinations of the water of crystallisation in borax, $Na_2B_4O_7$, H_2O, the atomic weight of boron is calculated as 10·928.—Rate of escape of ammonia from aqueous solution, by E. P. Perman. After drawing a volume V of air through a dilute solution of ammonia at a uniform rate, the amount q of ammonia left in solution is $\log q = a - bV$, where a and b are constants; with variable temperature t, $\log b = \alpha + \beta t$, α and β being constants.—On the dissociation of potassium platinichloride in dilute solution; and the production of platinum monochloride, by E. Sonstadt. Potassium platinichloride, in a 0·1 per cent. aqueous solution, is scarcely changed on heating; in a 0·01 per cent. solution platinum monochloride is gradually precipitated on heating, in accordance with the equations (1) $K_2PtCl_6 = 2KCl + PtCl_4$; and (2) $2PtCl_4 + 6H_2O = 2PtCl + 6HCl + 3H_2O_2$.—Effect of the mono-, di- and tri-chloracetyl groups on the rotatory power of methylic and ethylic glycerates and tartrates, by P. Frankland and T. S. Patterson. In order to ascertain the rotatory effect of the halogens when attached at a point in the molecule remote from the asymmetric carbon atom, the authors have examined the mono-, di- and tri-chloracetyl derivatives of the methylic and ethylic tartrates and glycerates; tables of the optical data are given.—The rotation of ethylic and methylic dimonochloracetyltartrates, by P. Frankland and A. Turnbull.

MANCHESTER.

Literary and Philosophical Society, January 25.—Mr. J. Cosmo Melvill, President, in the chair.—Mr. Louis Schwabe was elected an ordinary member of the Society.—The President referred to the loss sustained by the Society through the death of Mr. Thomas Ashton, who, since the death of Mr. James Heywood, was the "Father" of the Society, having been elected in 1837.—Mr. J. J. Ashworth called attention to a paper by Mr. J. Smith, in vol. xxi. of the Society's "Memoirs" (1859) on the origin of colours and the theory of light, in which is given a complete description of the colour phenomena seen when a black and white disc is rapidly rotated. As the phenomena have been to some extent re-discovered during the past few years, and have attracted considerable interest, he thought it advisable to direct attention to a paper which appeared to have been forgotten, in which the subject is treated with great thoroughness.—*Apropos* of an inquiry at a recent meeting of the Society, as to the origin of wheat, the President exhibited specimens of *Ægilops*, *Triticum*, and *Agropyrum* from his herbarium. Mention was made of a grass, *Ægilops ovata*, L., which was declared by a French botanist some fifty years ago to become wheat on being cultivated, and subsequent experiments appeared to confirm this statement. The opinion generally held by botanists now, however, is that in all probability wheat had its origin in *Triticum monococcum*, L., a plant found in Asia Minor, Mesopotamia and Greece.—Mr. Melvill afterwards communicated a paper by Mr. Peter Cameron entitled "Hymenoptera Orientalia, or Contributions to a Knowledge of the Hymenoptera of the Oriental Zoological Region," part vii.

February 8.—Mr. J. Cosmo Melvill, President, in the chair.—Mr. Brothers exhibited and described the latest form of Mr. F. E. Ives' photo-chromoscope, called the "Krōmskōp." Stereoscopic photographs were shown in which the various objects, when viewed through the arrangement of red, blue, and green glasses, were seen in all the colours of nature-groups of flowers, landscapes, &c., being thus realistically reproduced.—On the collision of two explosion-waves, by Messrs. R. H. Jones and J. Bower. This paper was a description of experiments carried out in the research laboratories of Owens College to examine whether there was any increase of pressure on the collision of two explosion-waves. This was shown to be the case, both by direct hydraulic tests of the tubing used and by photographs of the explosions. It was also argued that the increased luminosity at the point of collision and the increased speed of the reflected wave from the point of collision above that of reflection from a hard surface established the fact of greater pressure.

PARIS.

Academy of Sciences, February 7.—M. Wolf in the chair.—The President announced to the Academy the death of M. Jean Albert Gauthier-Villars.—Histological mechanism of cicatrisation; immediate synaptic reunion, by M. L. Ranvier. If two parallel incisions of equal length are made in the cornea of the rabbit, one going only a third to a half through the membrane, the other penetrating right through into the chamber behind, the latter heals more quickly than the simple wound. These effects are due to the part played by fibrin in cicatrisation.—On the development of real non-analytical functions, by M. P. Painlevé.—Transparency of bismuth in a magnetic field, by M. H. Buisson. The electromagnetic theory of light requires a relation between the transparency and electrical resistance of a body. By placing a thin sheet of bismuth in an intense field caused by an electromagnet, it is possible to cause sudden variations in the resistance of the plate. Since not the slightest variation in the intensity of the transmitted light could be detected under these conditions, the author concludes that the conductivity which intervenes in luminous phenomena is probably of a different order to that ordinarily measured.—Cycles of magnetic torsion and the residual torsion of soft iron, by M. G. Moreau.—On a method of comparing curves of torsion, by M. H. Bouasse.—Transformation of the X-rays by transmission, by M. G. Sagnac. A continuation of preceding work on the properties of the secondary rays, or rays emitted by bodies struck by the X-rays.—On photographic development, by M. R. Colson.—On the melting points of gold and silver, by M. Daniel Berthelot. The metals in the form of wire were heated in the furnace described in a previous paper, and the temperature of fusion measured by a platinum-iridium thermo-

couple, the latter being standardised in place by the interference method of air thermometry previously described. The temperatures found were 962° C. for silver and 1064° for gold.—Determination of the density of gases upon very small volumes, by M. Th. Schlœsing, jun. (see p. 374).—On the correlation between reduction by nascent hydrogen, electrolysis, and photolysis of carbonic acid, by M. A. Bach. The reduction of a solution of carbon dioxide in water by hydrogenised palladium gave rise to some formic aldehyde, the latter being identified by conversion into methylene-aniline and hexamethylenetetramine. The electrolytic reduction of carbon dioxide is shown to be parallel with the reduction by solar radiation.—On the aromatic urethanes of conicine, by MM. P. Cazeneuve and Moreau,—New colour reaction of phenylhydrazine, by M. Louis Simon. The solution of the hydrazine is warmed with a little aqueous trimethylamine, some drops of a solution of nitroprussiate of soda added, and then concentrated potash. A blue coloration results which allows of the detection of one part of phenylhydrazine in 50,000 of water.—On the influence of the frequency of the movements and of the weights sustained upon the maximum power of muscle under regular treatment, by MM. André Broca and Charles Richet.—On the development of the conjunctive fibrilla, by M. P. A. Zachariadès.—On the constitution of cannel coal, by M. B. Renault.—On the polymorphism of fluorspar, by M. F. Wallerant.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 17.

ROYAL SOCIETY, at 4.30.—On the Connection between the Electrical Properties and the Chemical Composition of Different Kinds of Glass: Prof. A. Gray, F.R.S., and Prof. J. J. Dobbie.—On the Magnetic Deformation of Nickel: Dr. E. Taylor Jones.—Upon the Structure and Development of the Enamel of Elasmobranch Fishes: C. S. Tomes, F.R.S.—On Artificial Temporary Colour-Blindness, with an Examination of the Colour Sensations of 109 Persons: G. J. Burch.—Contributions to the Mathematical Theory of Evolution. On the Inheritance of the Cephalic Index: Cicely Fawcett, and Prof. K. Pearson, F.R.S.

ROYAL INSTITUTION, at 3.—Some Italian Pictures at the National Gallery: Dr. Jean Paul Richter.

SOCIETY OF ARTS (Imperial Institute), at 4.30.—The Plague in Bombay: Dr. Herbert Mills Birdwood.

LINNEAN SOCIETY, at 8.—On the Genus Arenaria: F. N. Williams.—On the Histology of the Salivary and other Glands of the *Colubridæ*: G. S. West.

CHEMICAL SOCIETY, at 8.—Some Lecture Experiments: J. Tudor Cundall.—Observations on the Influence of the Silent Discharge of Electricity on Atmospheric Air: W. A. Shenstone and W. T. Evans.

FRIDAY, FEBRUARY 18.

ROYAL INSTITUTION, at 9.—A Yorkshire Moor: Prof. L. C. Miall, F.R.S.

GEOLOGICAL SOCIETY, at 3.—Annual General Meeting.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Relationship of Variations of the Ground-Water Level to the Incidence and Seasonal Distribution of Malarial Fevers in India: Surgeon-Captain Leonard Rogers.

SATURDAY, FEBRUARY 19.

ROYAL INSTITUTION, at 3.—The Structure of Instrumental Music: William H. Hadow.

MONDAY, FEBRUARY 21.

IMPERIAL INSTITUTE, at 8.30.—The Nile and its Tributaries: Colonel C. M. Watson, R.E., C.M.G.

SOCIETY OF ARTS, at 8.—The Principles of Design in Form: Hugh Stannus.

VICTORIA INSTITUTE, at 4.30.—Purpose in Nature: Dr. W. Kidd.

TUESDAY, FEBRUARY 22.

ROYAL INSTITUTION, at 3.—The Simplest Living Things: Prof. E. Ray Lankester, F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Ethnographical Notes on the Murray Islands, Torres Straits: Rev. Archibald E. Hunt.—There will be exhibited two Tattooed Heads carved in Kauri Gum from New Zealand, lent by Edge Partington; and a Collection of Objects obtained during the Recent Exploration of a Cairn in Breconshire, lent by T. C. Cantrill.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Theory, Design, and Practical Working of Alternate-Current Motors: Llewelyn B. Atkinson.—Dublin Electric Tramways: H. F. Parshall.

WEDNESDAY, FEBRUARY 23.

SOCIETY OF ARTS, at 8.—Children's Sight: R. Brudenell Carter.

THURSDAY, FEBRUARY 24.

ROYAL SOCIETY, at 4.30.—Meeting for Discussion.—Subject: The Scientific Advantages of an Antarctic Expedition. The Discussion will be opened by Dr. John Murray, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—On the Manufacture of Lamps and other Apparatus for 200 volts Circuits: G. Binswanger Byng.

FRIDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 9.—The Theory of Colour Vision applied to Modern Colour Photography: Captain W. de W. Abney, C.B., F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Problem of Train Resistance: C. E. Wolff.

SATURDAY, FEBRUARY 26.

ROYAL INSTITUTION, at 3.—The Structure of Instrumental Music: W. H. Hadow.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Arrangement of Atoms in Space: J. H. van 't Hoff, 2nd edition, translated and edited by A. Eiloart (Longmans).—On Laboratory Arts: Prof. R. Threlfall (Macmillan).—Motion: its Origin and Conservation: Rev. Dr. W. McDonald (Dublin, Browne).—Calendar, &c., of the Department of Science and Art, 1898 (Eyre).—Evolutional Ethics and Animal Psychology: E. P. Evans (Heinemann).—The Flora of Berkshire: G. C. Druce (Oxford, Clarendon Press).—Researches on Tuberculosis: Dr. A. Ransome (Smith, Elder).—Pasteur: Prof. and Mrs. P. Frankland (Cassell).—Lehrbuch der Entwickelungsgeschichte des Menschen: Dr. J. Kollmann (Jena, Fischer).—Organographie der Pflanzen: Dr. K. Goebel, Erster Teil (Jena, Fischer).—Das Optische Drehungsvermögen: Dr. H. Landolt, Zweite Auflage (Braunschweig, Vieweg).—Die Gattung Cyclamen L.: Dr. F. Hildebrand (Jena, Fischer).

PAMPHLETS.—Museum Handbooks: Catalogue of the Hadfield Collection of Shells from the Loyalty Islands, Parts 2 and 3 (Manchester, Cornish).—A Visit to Giessen: Prof. Senier (Dublin, Ponsonby).

SERIALS.—Physical Review, November, December, and January (Macmillan).—American Journal of Psychology, January (Worcester, Mass.).—Observatory, February (Taylor).—Bulletin de la Société Impériale des Naturalistes de Moscou, 1897, No. 2 (Moscou).—Geographical Journal, February (Stanford).—Boletim do Museu Paraense, &c., Vol. 2, No. 2 (Parà, Brazil).—Quarterly Journal of Microscopical Science, January (Churchill).—Engineering Magazine, February (222 Strand).—Atlantic Monthly, February (Gay).—Zeitschrift für Physikalisches Chemie, xxv. Band, 1 Heft (Leipzig, Engelmann).—Annales de l'Electrobiologie, &c., No. 1 (Paris, Alcan).—Memorias y Revista de la Sociedad Cientifica, Tomo x. Nos. 5–12 (Mexico).—Memoirs of the Boston Society of Natural History, Vol. v. No. 3 (Boston, Mass.).—An Illustrated Manual of British Birds: H. Saunders, 2nd edition, Part 4 (Gurney).—Journal of the Institution of Electrical Engineers, Feburary (Spon).—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. 42, Part 1 (Manchester).—American Journal of Science, February (Newhaven).—Among British Birds in their Nesting Haunts: O. A. J. Lee, Part 9 (Edinburgh, Douglas).—The West Australian Settler's Guide and Farmer's Handbook, Part 5 (Perth, W.A., Wigg).

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THURSDAY, FEBRUARY 24, 1898.

THE MAGNETIC CIRCUIT.

The Magnetic Circuit. By H. du Bois, Ph.D. Translated by E. Atkinson, Ph.D. Pp. xviii + 362. (London: Longmans, Green, and Co., 1896.)

NO one is better fitted than Dr. du Bois to write a treatise on the magnetic circuit. He is well known for his experimental investigations in magnetism, and abstract magnetic theory is clearer and more comprehensive for his restatement of its main propositions. His German treatise, "Die Magnetische Kreise," published some five years ago, attracted considerable attention in this country. It gave in reasonable compass an excellent account of magnetic theory, methods of magnetic measurement, and of recent magnetic research, in which Dr. du Bois' own contributions to knowledge formed an important part, not merely on account of their intrinsic value, but of their clear and first-hand and withal modest statement.

A translation of this book, made by Dr. Atkinson with the assistance and revision of the author, and one or two other experts in the subject, was published in 1896, and was thoroughly welcomed by the already considerable and continually increasing number of experimentalists in electricity and magnetism. Some apology for so late a review of so important a work is necessary, and this is now offered by the reviewer, whose fault it has been that an account of it has not long before now appeared in NATURE. Still "good wine needs no bush,' and the work of Dr. du Bois carries its own guarantee of excellence on the face of it.

The book begins with a very valuable summary of magnetic quantities and conceptions, in which the fundamental ideas of magnetic force, magnetic induction, intensity of magnetisation, permeability and susceptibility, &c., are fully explained, and the graphical representation of their values for actual cases is fully illustrated by curves of induction and magnetisation obtained for actual specimens of iron and steel.

The question of the effects of the ends of a bar of magnetised iron or steel, or of a narrow crevasse or joint between two parts of a bar or ring, is taken up towards the end of Chapter i., and is continued in Chapter ii. Ewing's representation of the effect of the cut, by a shearing of the curve of magnetisation for the uncut bar or ring, is given, and illustrated, as before, by the results of actual investigations—mostly those of Ewing himself. The effect of a cut leads to a further discussion of that of an end, and thence to a discussion of Coulomb's law for the distance action of a magnetic pole, and of the field at a point due to a pair of equal and opposite "point-charges" of magnetic matter.

Of course this action at a distance is what is actually observed, and there is an advantage in starting with what are the immediate results of experience. Still, if the book, as no doubt it will, should pass soon to a new edition, we should like to see some account of a more "mediumistic" view of the matter included. It is possible, and in connection with the electromagnetic theory of light it is very desirable, to consider magnetic force and magnetic induction not only as both existing as directed quantities at every point of a magnetised body, but at every point of the electromagnetic field, in ether or other "interferric" material, as well as in iron itself. With electric induction and electric intensity also introduced as the analogues of the magnetic quantities, with k for the electric inductivity, and μ for the magnetic inductivity of the medium, whatever it may be, all difficulties as to units disappear if k and μ are regarded as depending upon real physical properties of the medium which, if fully known, would determine the dimensions of these quantities, and $1/k\mu$ is seen in a natural way to be the square of the velocity of propagation. The serious difficulties which students feel with respect to this matter, and which are only apparently overcome by an unsatisfactory process, are entirely avoided.

In Chapters iii. and iv. we have an Outline of the Theory of Rigid Magnets, and a discussion of Magnetic Intensity and Magnetic Induction. The account of rigid magnetism and of induction here given is based in the main on that source of all theory on the subject, Lord Kelvin's Mathematical Theory of Magnetism, and on the digest of this part of the subject given in Maxwell's great treatise, and includes most of the more valuable results obtained by Kirchhoff, and by later writers who have commented on or developed the theoretical principles laid down by these masters. Here Dr. du Bois has himself done good service. He has given solutions of important problems of induction, and generally, as stated above, in certain points improved the presentment of theory; work of which English readers now reap the full advantage.

A chapter on the Magnetisation of Closed and of Radially Divided Toroids, which is divided into two parts—(*a*) Theoretical; (*b*) Experimental—closes the first part of the treatise. This chapter is exceedingly important. Kirchhoff's theory of the magnetisation of a solid of revolution is given, and its results for rings of rectangular and circular section are deduced. This investigation of Kirchhoff's gave rise to the experimental investigations of Stoletow and Rowland, the results of which have only confirmed its correctness.

Results are next deduced for a radially divided ring, which are fully illustrated in the experimental investigations described later. Thus we have the subject of leakage of magnetic induction introduced and clearly discussed and illustrated. The great practical importance of this part of the subject will be obvious when its application to dynamo machines is considered, and a large part of the experimental investigations which have been carried out have had to do with the question of the distribution of tubes of induction in or near more or less narrow gaps in what may be regarded as closed circuits or rings of iron.

The great importance of having a magnetic circuit nearly closed was recognised by Faraday, and was more or less present to the minds of makers of magnets, both permanent and electro, down to the beginning of the present active manufacture, on a large commercial scale, of dynamo machines.

Then it was that Hopkinson came forward with his explicit statement of the laws of the magnetic circuit, and their application to the construction of the field magnets of dynamos, a piece of work for which practical

science owes him a heavy debt. The magnetic circuit, and the mode of testing the performance of dynamo machines by means of characteristic curves, which themselves give valuable information regarding the magnetisation of the circuit, really did for the dynamo machine very much what practical thermodynamics and the indicator did for the steam-engine.

After an account of the General Properties of Magnetic Circuits, Dr. du Bois proceeds in his Chapter vii. to a discussion of the Analogy of the Magnetic Circuit with other Circuits. Here the author, as we think very properly, condemns the use of the term "Ohm's Law" to express the fact that magneto-motive force in the circuit divided by the magnetic reluctance is equal to the flux of induction in the circuit. This, it has always appeared to us, is using the term "Ohm's Law" to describe what is a mere result of definition. The equality of the magneto-motive force multiplied by the permeance (permeance = 1/reluctance) of the circuit to the flux of induction is a result of definitions of induction and field intensity, and to thus use it is to introduce into magnetics the confusion which many have fallen into with regard to the law of Ohm in voltaic circuits. In the latter case, the law, properly speaking, expresses the proportionality of the current in a conductor to the difference of potential between two points in the conductor near its ends when the conductor is not the seat of any internal electromotive force. This result has no counterpart in magnetic circuits, and no "Ohm's Law" holds there.

In Chapter viii. the Magnetic Circuits of Dynamos or Electromotors is dealt with, the work of the brothers Hopkinson, the empirical formulæ for the magnetisation curves of such machines given by Frölich and others are all described, and the application of all this thoroughly practical theoretical discussion is focussed on the construction and arrangement of the field-magnets and armature of the machine.

We are immediately carried on in a natural sequence to magnetic cycles and hysteresis, and the immensely important researches on the magnetic properties of iron carried out by Ewing and others. The results in this field are, however, before all our readers specially interested in the subject, and the subject is so large and so full of detail, that we cannot with any advantage continue our sketch of the contents of the book.

The magnetic circuits of electromagnets, containing an account of the devices used by Ewing and the author to obtain very intense fields, and of methods of measuring such fields, is given in Chapters ix. and x. Up to about fifteen years ago determinations of field intensities had been confined to measurements of the earth's field-intensity or intensities of like magnitude, and a paper (*Philosophical Magazine*, 1882) by the present writer, describing methods which were in use in the Glasgow University Physical Laboratory, contained perhaps the first published statement of how the field between the poles of a powerful electromagnet could be quickly and accurately measured.

In this connection also we have one of the author's notable contributions to magnetics, in his account of the researches which he carried out at Berlin on the magneto-optical method of measuring intense fields.

Here we must conclude our review of a most fascinating book. It cannot be praised too highly as a piece of work sound from every point of view, and tending to the advancement of knowledge. Dr. Atkinson and his colleagues have performed their work of rendering the book into English very carefully indeed, and on the whole the version reads like a book originally written, and well written, in English. Only in one or two places have we found, in a fairly extensive comparison of the German and English, that the sense has not been exactly caught. For example, at p. 340 a method of investigation there referred to is rather hardly treated by being described as "circuitous." The German "umständlich" ought here to be rendered by "circumstantial."

A. Gray.

AUDUBON.

Audubon and his Journals. By Maria R. Audubon. With zoological and other notes by Elliott Coues. 8vo. Two vols. Vol. I., pp. xiv + 532; Vol. II., pp. viii + 554. Portraits, copies of diplomas, photogravures, &c. (New York: Charles Scribner's Sons, 1897.)

NATURALISTS and many who are not naturalists will find this an entertaining book. It gives in great detail the incidents of certain years of Audubon's life, years in which he was carrying on his work in the field, or else meeting every day men who are still noteworthy. The book is founded upon unpublished journals and letters, of which parts are given at length. All has been corrected by recollections handed down in the family, and the zoological information has been revised by Dr. Elliott Coues. A summary of the naturalist's life is prefixed. We have now a full and lively account of what is most memorable in the life of Audubon.

Some readers who are not naturalists will turn with curiosity to the passages in which mention is made of places which are now populous American cities, but which, when Audubon dwelt there, or passed through, were backwoods settlements. Others will be glad to note small particulars concerning the naturalists, merchants, and men of letters whom Audubon saw during his visit to Europe in 1826–29—Cuvier, Bewick, Jameson, Selby, Jardine, Rathbone and Roscoe. Others again will study the character and methods of a man, who partly by real merit, and partly by the good-luck of becoming known to men who could write, has been widely accepted as a typical naturalist. Some of us can hardly remember the time when we had not heard of Audubon as the man who faced all dangers and fatigues, caring nothing for comfort or profit, if only he could learn more and more of the wild creatures which fly from the face of man. There is matter here for readers of very different kinds, and all should thank those who have rescued so many old papers, and arranged them so carefully.

Audubon was a real naturalist, if ever there was one. He had the passion for observing and drawing birds almost as a gift of nature. As a boy and young man he was fit for nothing else, but the responsibility which a family brings made him in middle life a sensible man of business. He was never a man of science. He never received from others, nor gave himself any kind of training in scientific method; he never studied the anatomy of

birds or systems of classification; above all, he never put questions of the slightest scientific interest. It was enough for him to draw his birds as they looked when alive, and now and then to note some curious detail in their mode of life. His less famous helper, MacGillivray, was far better furnished and far more productive. Audubon's "Birds of America" has great artistic merit, but less scientific value than a good series of photographs from life.

Audubon's career is now revealed to us more fully and more pleasantly than in any earlier account. He was born of French parents at Mandeville, on Lake Ponchartrain, somewhere about 1780. His first seventeen years were spent almost altogether in France, and he showed his turn of mind by making 200 drawings of the birds of France. Then he was sent out to Philadelphia, where his father had landed property. After another two years in France he came back to America, which henceforth he always claimed as his fatherland. At first young Audubon lived like a young gentleman of property, hunting, fishing, shooting, skating, but drawing birds too. He was a bit of a dandy in those days, and a favourite with young ladies. He went into business, married, and should according to all expectation have settled down as a money-making American. But he was intent upon birds and not upon money. He was easily diverted from a business-journey by a glimpse of a new bird, and was regularly cheated by his partners, agents, employers and customers. He complained that one of his partners cared only for money; the partner on his side complained that Audubon had no turn for commerce, and was continually in the forest. The advantages with which he started were soon lost, and in a few years we find him roving about in America, giving drawing-lessons, music-lessons, dancing-lessons, drawing portraits, but always adding to his portfolio of birds, and always studying how to make his delineations more life-like. The hope of publishing his great collection gradually became more definite. In 1826, being then near fifty years old, he came over to Europe to get subscriptions and engage draughtsmen. His diary shows him to us as sobered down by this time to a modest, careful man, minding his chances, and thoughtful for his wife and children. His success in publishing the "Birds of America," his later ventures, his expeditions to Labrador, Florida and the Missouri River, as well as his charming family life, are all described in the book before us. In 1847 his faculties began to give way, and he died in 1851.

The "Birds of America" has maintained its reputation, in spite of its enormous bulk, its costliness, and its want of scientific utility. It is now a luxury, only to be possessed by the wealthy, and very seldom enjoyed even by them, an unprofitable jewel in comparison with the homely tools which the working ornithologist requires. To have published a book which very few men can afford to buy, gives a certain kind of distinction. Audubon has better claims upon our attention than this, but the ever-rising price of his "Birds of America" has helped his fame.

One thing in the journals moves our indignation, but it will hardly excite remark among the naturalists of to-day; we mean the profuse and needless slaughter of wild animals, which fills almost every page of the journals. Audubon rises in the morning, snatches his gun, shoots everything that shows itself, and then sits down to draw his victims. Some naturalists look upon all this bloodshed and torture as inevitable, or even enjoyable. That is the way to get together a museum of dried skins or a portfolio of drawings; it is not the way to solve scientific questions, nor to gain real insight into the works of nature.

L. C. M.

SEWER GAS AND HEALTH.

Sewer Gas, and its Influence upon Health. Treatise by H. A. Roechling, C.E. Pp. 224. (London: Biggs and Co., 1898.)

THERE is hardly a Corporation in the United Kingdom, we venture to say, to whose members sewer gas is not a hideous nightmare. It is the legacy of a bygone generation of hygienic enthusiasts, and is likely to prove the *bête noir* of many a succeeding generation of despairing sanitarians. Despite the brilliant achievements in the domain of hygiene of which the present century can justly be proud, the sewerage problem remains still a gordian knot the disentanglement of which seems as far off as ever.

Public opinion has swayed backwards and forwards, immense sums of money have been expended in what may be designated as vast hygienic experiments, sewers have been laid and relaid, ventilators introduced and abolished, and innumerable devices invented and applied in the hope of effectually getting rid of this mysterious and subtle influence in our midst.

Mr. Roechling in the above volume has added one more to the many indictments which have been published against sewer gas. These indictments are necessarily of a somewhat vague description, founded, as they must be, more on personal conviction than on strictly scientific facts; for our precise knowledge of the character and properties of this gas is at present so extremely limited, that we are frequently reduced to the manipulation of mortality statistics for a basis of attack. We must not, therefore, approach this book in the hope of finding a pyramid of new facts, for we may have to be satisfied with hardly a molehill, but we may recommend it as containing a useful summary of the circumstantial evidence which can be adduced against sewer gas.

The arrangement of the material, however, leaves much to be desired, and the writer is needlessly verbose. Considerably more than half the book is taken up with appendices, to which the preceding portion of the book has constant reference, and these appendices would be very much the better for judicious pruning. Page after page, for example, are devoted to detailed reports of cases of supposed poisoning through sewer gas; over twenty pages are occupied with reporting in full the legal proceedings connected with a case of blood-poisoning, &c. All this, no doubt, serves to swell the size, but it certainly does not increase the value of the volume.

As an example of the justifiably perplexed condition of some of our public authorities on the question of sewe gas, we may cite the case of Leicester as mentioned by the author. Up to the year 1881 the sewers of this city were in a very foul condition, and were not ventilated in any way, and the typhoid death-rate was as high as 32·2 per 100,000. In 1881, however, the Town Council decided to open up the sewers, thoroughly cleanse them,

and ventilate them by open covers at street level. Subsequent to this, and up to the year 1886 the typhoid death-rate showed a most remarkable decrease, falling during this period at its lowest to 16·3 per 100,000. Yielding, however, to the pressure of numerous public complaints about the obnoxious smells rising from the sewers in the various thoroughfares of the town, the Sanitary Committee decided in 1886 to close the open street ventilators, and to erect in their place cast-iron pipes up the sides of houses wherever the necessary permission of the house-owners could be obtained.

Since 1886, also, improvements have been made in the sewerage system of the town, for the old and small main sewers have been replaced by larger and better constructed ones at a cost of nearly 200,000*l.*; but in spite of this and other sanitary improvements, the typhoid death-rate has actually risen in Leicester during this latter period. *Felix qui potuit rerum cognoscere causas!*

It must indeed be frankly admitted that our knowledge of the conditions—and there may be many factors, which determine outbreaks of epidemic disease—is at present in some respects hopelessly inadequate. No more conclusive example of this is to be found than is presented by the diphtheria epidemic which has taken such a firm hold of London, and which has also manifested itself in various other parts of the country, and, despite all the boasted hygienic enlightenment of the closing years of the century, pursues its triumphant course practically unchecked.

Sewer gas may be charged with a great deal, but we also know that other factors—as, for example, infected water and milk—are also heavily weighted with responsibility in the dissemination of disease, and that to shift the whole burden of a particular epidemic upon any one single factor becomes the more unreasonable the wider our scientific horizon is extended.

G. C. FRANKLAND.

OUR BOOK SHELF.

Chambers's Algebra for Schools. By William Thomson, M.A., B.Sc., F.R.S.E. (London: W. and R. Chambers, 1898.)

THIS is a plainly written and well-arranged book of secondary grade, quite worthy of the crucial test which only practical teachers can apply. Among its praiseworthy features may be mentioned the attention paid to degree, homogeneity, and symmetry; the early introduction of the method of detached coefficients; and the elementary discussion of graphs. The chapter on indices is more satisfactory than is usually the case in works of this kind; on the other hand the chapter on surds is disappointingly conventional, and that on logarithms might certainly be revised with advantage. All logarithmic calculations ought to be printed in the form in which a computer would write them down on paper; explanations, of course, may be added when necessary.

The chapter on the binomial theorem for any exponent is not satisfactory: it would be much better simply to state the conditions under which the theorem is true, and to give some numerical examples to illustrate the use of it for purposes of approximate calculation.

The examples are numerous, and there is, on the whole, a refreshing absence of those fantastic absurdities which are never found except in text-books and examination papers. In the examples on variation, illustrations derived from physics might very well have been inserted: the same thing may be said about the examples on equations.

It is probably useless to protest against the method of solving quadratics by completing the square; like the Imperial system of weights and measures, it has become a national fetish, and its cult is proof against all the arguments of common sense. G. B. M.

Die Kraft und Materie im Raume. Grundlage einer neuen Schöpfungstheorie. By A. Turner. Fifth edition. Pp. xxiv + 407, and 20 plates. (Leipzig: Theod. Thomas, 1897.)

IN his preface to the present edition of this work the author remarks:—

"We have given positive proofs of the untenability and the imaginary foundation upon which rest the hypotheses which have for their subject-matter the theory of vibration of a cosmic ether, whether these relate to light, heat, or to the artificial terms under the ægis of 'the conversion of work into heat, energy into electricity, &c.,' in short the greater part of the hypotheses which form the foundation and chief support of the privileged sciences of to-day.

"They represent no scientific truths, but, together with the catch-words indicated, serve merely as a cloak for ignorance, their supporters having no suspicion of the nature or true inwardness of the phenomena in question or of their causal connection."

Turning to the body of the work we find, expressed in somewhat similar style, a theory of the universe postulating matter and space as ultimate realities. Matter consists of centres of force attracting or repelling each other when they approach each other within certain limits. Light is the impression made on the optic nerve by radiant matter. The phenomena of heat are due to the repulsion of one substance by another, and so on. At the end of the book 150 theses are printed for the convenience of those who feel impelled to combat the author's views.

The Observer's Atlas of the Heavens. By William Peck, F.R.A.S., F.R.S.E. Charts 30; pp. 32. (London and Edinburgh: Gall and Inglis.)

THIS volume contains catalogues giving information relating to double stars, variable stars, nebulæ, and other celestial bodies, together with thirty star charts in which the positions of nine thousand objects are shown.

The charts include the whole celestial sphere, and are drawn to a large scale, five degrees of a great circle being equal to one inch. They are arranged so that, as far as possible, each constellation is shown complete in itself. The scale of magnitudes is well chosen, the stars appearing with the same relative importance on the charts as in the heavens. The practical value of the atlas would be greatly enhanced, however, if a scale of magnitudes were attached to each chart.

The brighter stars, down to the third magnitude, are shown to a half, and fainter stars to a whole magnitude. To facilitate identification in the various catalogues, either a letter or Flamsteed number is attached to every important star. A commendable feature is the insertion of the various data, from which the charts were compiled, in the form of catalogues of the different celestial bodies. These catalogues will be found very useful, and include such information as the magnitudes of the brighter stars to the nearest tenth, and the positions of stars down to the fourth magnitude, with their Flamsteed and British Association numbers.

Other useful information is included, such as diagrams showing the appearances of over one thousand double stars when near the meridian, and a chart of the moon with an index.

Undoubtedly, this atlas will be found very useful by astronomical observers, especially amateurs, for whose requirements it seems to be particularly designed.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Protective Mimicry and Common Warning Colours.

I HAVE just read with interest Sir George Hampson's criticism of certain supposed examples of protective mimicry. Such outspoken attacks are satisfactory in bringing out the truth one way or the other; and they contrast very favourably with vague expressions of opposition unaccompanied by reasons, and not stated in a manner or on an occasion which would permit reply.

I find from his letter that insufficiently supported conclusions are not confined to those who accept the theories in question. Sir George Hampson described a new geometer (*Abraxas etridoides*) from a single specimen in a private collection, and pointed out its resemblance to a *Teracolus* (*T. etrida*) from the same part of the world. Colonel Swinhoe directed the attention of the President of the Entomological Society to the resemblance, considering that it supported his (the Colonel's) contention that *Teracolus* is a protected genus. From these facts Sir George Hampson draws the remarkable conclusion that Colonel Swinhoe had in all probability never seen the species of *Abraxas* referred to. I give the inference in his own words—"this was quite enough for such an ardent student of mimicry as Colonel Swinhoe to base the statement on, without knowing any more of the species, and probably without ever having seen it, the type being in a private collection." The last reason would be more convincing if it was not followed by the statement—"I have, however, lately received more specimens." If Sir George Hampson, why not Colonel Swinhoe? As a matter of fact, Colonel Swinhoe received several specimens of *Abraxas etridoides* many months before he wrote to the President about them. There is a specimen in the Hope Collection here, presented by him in the early summer of last year.

All this does not affect the theory of mimicry. But the letter goes on to argue that the resemblance cannot be mimetic because the *Abraxas* rests in damp woods, while the *Teracolus* is flying on the plains 6000 feet below; and, furthermore, that the former is protected by distastefulness, while the latter is not. Similar objections are then raised against the supposed mimetic resemblance of Chalcosid moths to Danaine and Papilionine butterflies.

Now I quite agree that these criticisms, and especially that of the special protection of the moths, are destructive of any interpretation of the resemblance based on Bates' theory of protective mimicry. But they do not similarly affect that theory of mimicry (or more accurately common warning [synaposematic] colours) which we owe to Fritz Müller. Being aware of the distasteful qualities of *Abraxas*, I had at once placed the example under the latter category and not under the former.

The Müllerian theory supposes that a common type of appearance among distasteful insects in the same locality acts as a common advertisement to enemies, so that the loss of life which must ensue during the time in which each generation of enemies is being educated to avoid the owners of a particular type of pattern and colouring, is shared between these species instead of being borne by each of them independently.

Prof. Lloyd Morgan's recent experiments on young birds of many species prove that there is no inherited knowledge of suitability or unsuitability for food, but that everything of an appropriate size and at the right distance is pecked at and tested. On the other hand the young birds are extremely quick in learning, and have very retentive memories. Furthermore one unpleasant experience makes them suspicious of other things, and they remember well the appearance of the insect which gave them a disagreeable surprise. Many more such experiments are needed, but taken alone they go far to show that the education of young birds is actually of the kind which is presupposed by Fritz Müller's theory.

And what is true of birds is probably true of other animals as well. My experience with lizards points in the same direction.

Sir George Hampson has previously pointed out that birds sometimes devour *Teracoli*; but I have induced a lizard, by hunger, to eat an *Abraxas*. It is probable that *Teracoli* are, *on the whole*, avoided by birds; and if this is also true of the *Abraxas*, the resemblance may well be advantageous in spite of the difference in habits and the difference of station, even granting that the "good round sum" of 6000 feet is an absolute barrier to the *Teracoli* below and the *Abraxas* above. But future investigation may show that they approach much nearer than this.

The facts brought forward in Sir George Hampson's letter, while, I submit, by no means fatal to the Müllerian theory of mimicry, seem to be entirely destructive of the other suggestions by which the attempt has been made to explain these resemblances—suggestions which depend upon similarity in climatic or other physical or chemical conditions connected with locality

The last paragraph of the letter demands a word of protest. If insufficient field observations have been made, it is because the observers have thought of other things, and chiefly the amassing of specimens; but it is, in part, due to the extreme difficulty of the observations themselves. And under any circumstances the museum work was necessary for the theory. Mr. Godman, in his presidential address to the Entomological Society, told us that the theory was suggested to Bates as a result of the comparison of specimens at home, although of course his memory of observations in the field was also necessary. The work in the study enabled him to bring under observation at a single time the captures which were separated by great intervals of time and space; and no doubt it was the opportunity thus afforded of taking a broad view of the resemblances as a whole, which enabled him to originate the theory.

It seems strange that a writer whose energetic and successful work has involved so much "matching of specimens in a drawer," should speak of mimicry as "degraded" by such study. It is a necessary and important study for the naming of species as well as the recognition of examples of mimicry, and as such it deserves respectful attention, although it may at times have led to the creation of "museum-made" species on an even larger scale than the manufacture of "museum-made mimicry."

The matching of ribbons of uniform colour can hardly be compared with any degree of fairness to the matching of the complex patterns on the wings of Lepidoptera; but in the matching of highly developed specimens of decorative art by the anthropologist, and in the attempt to determine whether the resemblance is due to a common origin, or to accident, or to the mind of man working independently along the same lines, we have problems which present much in common with those confronting the student of mimicry.

In conclusion it may be well to remind those who oppose the theories of mimicry on the ground that the evidence is not demonstrative, that we believe in evolution although we do not see one species growing into another. We believe the theories of mimicry and of common warning colours, not because we have before us demonstrative proof in a complete knowledge of the details of the struggle for existence—it will be very long before we attain to this—but for the same reason that we believe in evolution—because the theory offers an intelligible explanation of a vast number of facts which are unexplained by any other theory as yet brought forward, and especially because it enables us to predict the existence of facts which we can afterwards verify.

EDWARD B. POULTON.

Oxford, February 18.

Oat Smut as an Artist's Pigment.

WITH reference to Mr. David Paterson's interesting letter in NATURE for February 17 (p. 364), it may be noted that a copy of an etching from a painting by Berghem, in the Kew Museum, No. 2 (Case 115, No. 200), is drawn with smut of wheat (*Ustilago Tritici*), and that, according to Dietel (*Die Naturlichen Pflanzenfamilien*, Th. I. 1 Abth. p. 6), ladies in Japan are accustomed to use the dark olive-brown spores of *Ustilago esculenta* as a pigment for painting the eyebrows.

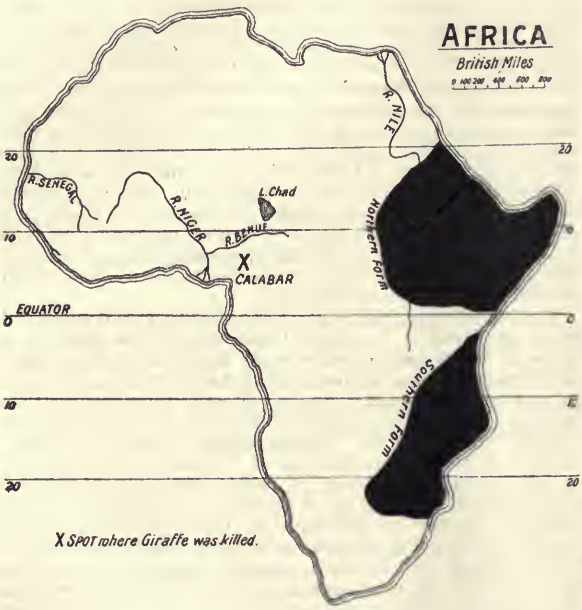
H. MARSHALL WARD.

Botanical Laboratory, Cambridge, February 18.

Giraffe from the Niger Territories.

MY brother, the late Lieut. R. H. McCorquodale, of the 3rd Dragoon Guards, while doing special service duty in West Africa, was fortunate enough to kill a very fine giraffe (female). This is a most interesting record, as it is the only specimen

that has ever been obtained in these regions. The skull, which was sent home to me, along with a considerable number of heads of antelope, lion, leopard, &c., is now in the British Museum, and Mr. Oldfield Thomas, of that institution, has compared it with the skulls of both the Northern and Southern forms; such marked differences have been noticed, that opinion is in favour of the possibility of its being a new species—for the time being, until it has been more fully worked out, he has made it a special sub-species, and named it *Giraffa camelopardalis peralta.* The giraffe was killed south of the Benue River, north of Calabar. The accompanying map will roughly show the geographical distribution of the two known forms, the haunts of these animals being filled in. Although one or two specimens



have been recorded on the eastern shores of Lake Chad, and also on the Senegal River, from 10° N. to 20° S. of the equator no fact is on record of a giraffe having been seen or killed within the degrees mentioned in all that part designated West Africa. The map will show at a glance the immense tracts of country between the habitats of these animals and the spot where this single animal was killed. In a letter I had from Sir George Taubman Goldie, the Governor of the Niger Company, he says: "This is the only giraffe ever known in these regions; I have no doubt there are others, but they have never been seen."

The above facts were mentioned by me at a meeting of the Linnean Society, on the 20th of last month; and Mr. Thomas exhibited the skull at the Zoological Society on the 1st inst., and among some of his remarks stated the skull to be the largest he had ever seen.

W. Hume McCorquodale.

Abridged Long Division.

Having been working on similar lines for some years, I was very much interested in the late Mr. Dodgson's letter on abridged division in Nature of January 20, and I should like to offer a few observations and to give a variation of the method which appears much simpler. It will be admitted that Mr. Dodgson's plan is of limited application, and rather complicated for general use. There is nothing to hinder the method given below from being universally used, though it may not in all cases be the shortest. It also has the merit, I think, of directness and uniformity.

It is, of course, based on the theorem in geometrical progression.

$$\frac{N}{ar^n \mp m} = \frac{N}{ar^n} \pm \frac{mN}{(ar^n)^2} + \frac{m^2N}{(ar^n)^3} \pm \ldots \frac{m^{n-1}N}{(ar^n)^n},$$

e.g. (1) Divide 246813579 by 989. Here $a = 1$, $r = 10$, $n = 3$, $m = 11$.

$$\begin{array}{r|l}
1000 & 246813579 \\
246813 & 579 \times 11 = 2714943 \\
2714 & 943 \times 11 = 29865 \\
29 & 865 \times 11 = 330 \\
 & 330 \\
\hline
249558\cdot717 & \text{quotient.}
\end{array}$$

It will be observed that in multiplying by $m = 11$, we need only use the figures to the left of the line, and if the first figure to the right of the line be > 5, call it one more; thus,

$$2715 \times 11 = 29865, \text{ and } 29\cdot 8 = 30 \times 11 = 330.$$

If extreme accuracy be required, the computer has only to carry the process further.

In this example we need not do so, as the divisor is 1000 throughout.

(2) Divide 975318642 by 3997.

$$\begin{array}{r|l}
4000 & 975318642 \\
243829 & 6605 \times 3 \div 4 \\
182 & 8722 \times 3 \div 4 \\
 & 1372 \\
\hline
244012\cdot 6699 & \text{quotient.}
\end{array}$$

Remainder in integers

$$= 8642 - (2 \times 4000 - 4012 \times 3) = \underline{2678}.$$

The 8642 and 4012 are the $n + 1$ figures of dividend and quotient respectively.

(3) Divide 12345678975312468 by 69993.

$$\begin{array}{r|l}
70000 & 12345678975312468 \\
176366842504 & 46 \times 7 \div 7 = \times 1 \\
17636684 & 25 \\
1763 & 66 \\
 & 17 \\
\hline
\text{Quotient } 176384480952 & 5
\end{array}$$

Actual remainder

$$= 312468 - (2 \times 70000 - 80952 \times 7) = \underline{39132}$$

retaining only the last $n + 1$ figures.

(4) Divide 975312468 by 7003.

$$\begin{array}{r|l}
7000 & 975312468 \\
139330 & 353 \times 3 \div 7 \\
59 & 713 \\
\hline
\text{Quotient } 139270 & 6
\end{array}$$

Actual remainder $2468 - (0 \times 7000 + 9270 \times 3) = \underline{4658}$, retaining only last $n + 1$ figures.

It will be noticed here that we subtract to get the quotient. The reason is evident. We actually divide by 7000 instead of 7003, and therefore the quotient is too great.

If the remainder be known, as *e.g.* in recurring decimals, the following process, published by me some years ago, is shorter than the ordinary method, besides possessing the advantage of *finding its own quotient.*

Divide 85296419765·1 by 9731

$$\begin{array}{r}
\underline{973} \\
41879\cdot 2 \\
\underline{1946} \\
3993\cdot 3 \\
\underline{2919} \\
6107\cdot 4 \\
\underline{3892} \\
9221\cdot 5 \\
\underline{4865} \\
52435\cdot 6 \\
\underline{5838} \\
84659\cdot 7 \\
\underline{6811} \\
7784\cdot 8 \\
\underline{7784} \\
\ldots\ldots
\end{array}$$

The quotient 87654321. It is obtained the reverse of the ordinary way.

This method bears the same reverse relation to ordinary

division as the left method does to the right in an ordinary multiplication, *e.g.*

(1)	(1)	(2)	(2)
321	321)241713(753	321	24171·3
753		753	
2247	2247	963	96
	1701		407·5
1605	1605	1605	160
963	963	2247	224·7
241713	963	241713	224
	....		

Anfield Road, Liverpool. ROBT. W. D. CHRISTIE.

Earthquake in North Britain.

IT may be of interest to you to note that on Wednesday, February 16, at about 1.35 p.m., a sharp shock of earthquake was felt here. Houses were shaken, dishes rattled and tumbled, and much alarm was created, though no damage was done. At the time mentioned there was a loud report, as if of a heavy shot fired underground: earth movements—such as would result from violent concussion—immediately followed, lasting for about two seconds; the character of the movements then seemed to alter from vertical to horizontal, the latter being sustained for nearly four seconds. About two minutes after the first report a second was heard, louder and sharper than the first, but no tremors were felt. Judging from the sounds, it would appear that the wave travelled from west to east.

I may state that within recent years several shocks of earthquake have been felt in the district.

Kilsyth, N.B., February 18. JAMES M'CUBBIN.

ON THE USE OF GLYCERINATED CALF LYMPH FOR PROTECTIVE VACCINATION AGAINST SMALL-POX.

THE terms of the Report of the Royal Commission on Vaccination, published towards the end of the year 1896, made it evident that there was a general feeling on the part of the Commissioners that the use of calf lymph should be encouraged as far as possible; and it was patent to those who grasped the full significance of the Report, that in order to fall in with popular sentiment, even apart from other considerations, some effort would be made by those in authority to examine carefully into the claims advanced on behalf of calf lymph vaccination as carried out at home and in European countries. For some time past it has been recognised by those who have been cognisant of Dr. Monckton Copeman's work on the "glycerination" of vaccine lymph, and especially of that derived from the calf, that the advantages connected with the use of this lymph are of such a nature that many of the objections that have been urged against the use of calf lymph are practically eliminated. Although this work has been going on in our midst, it appears that, in order to obtain any knowledge of the practical outcome of Dr. Copeman's investigations, we are compelled to turn our attention to the large vaccine establishments of France, Germany, Belgium and Switzerland, where, under State control, the use of glycerinated calf lymph has now come to be recognised as the method, of all others, which is attended with the greatest success.

The addition of a certain bulk of glycerine to vaccine material does not at first sight appear to be a very important matter, but, as Dr. Copeman has demonstrated, this glycerine does exert an extraordinary influence.

Taking the method employed in the Institute in Berlin as an example, we find that the vesical pulp collected from a single calf weighs from 10 to 15 grammes; to this is added a mixture of glycerine and water of equal parts, fourteen times the bulk of the vesicular pulp; it then, if used carefully, forms a sufficient volume to vaccinate 15,000 individuals.

All this we learn from the Report drawn up by the Medical Officer of the Local Government Board, in conjunction with Dr. Monckton Copeman, published in "The Supplement containing the Report of the Medical Officer for 1896-97 to the Twenty-sixth Annual Report to the Local Government Board."

The advantages early claimed by Dr. Copeman for this method are:

(1) That the addition of glycerine in this diluted form has the effect of ensuring the destruction of micro-organisms that are sometimes found even in the calf lymph collected under the very best conditions. It has been maintained that certain of the cases of erysipelas that have followed vaccination with calf lymph have been due to the accidental presence of certain of these organisms. Again, the possibility of infection with tubercle has sometimes been raised, though there is very little evidence of such infection being conveyed by vaccination; still the point has been raised, and it is right that it should be considered as a possibility. Glycerination of the lymph entirely does away with any danger from either of these or other allied sources. The addition of the glycerine kills off not only non-pathogenitic microbes, but such pathogenitic organisms as are ever likely to be found in vaccine lymph. This in itself, then, is a forward step of vital importance to those who, whilst fully convinced of the advantages of vaccination, and of the enormous preponderance of these over the possible disadvantages, are desirous that such disadvantages as there are shall be removed, and that every cause of objection should be done away with for those who have conscientious, even though unfounded scruples, against the use of lymph taken from the child, or from the calf under ordinary conditions.

(2) The dilution with glycerine appears to have absolutely no effect in diminishing the specific activity of the lymph, although it affects the bacterial flora of the lymph in such a marked degree. It is even maintained that such specific activity is actually increased, though it is difficult to see how this can be the case. It is possible, however, that various changes set up by bacteria are inhibited, and that in consequence the active elements in the lymph remain in a stable and unaltered condition for a longer period.

It is interesting to note in this connection that, although the lymph is diluted some fourteen or fifteen times, it remains sufficiently active at the end of three or four weeks to produce a good crop of vesicles when the same amount of the dilute fluid is used as is ordinarily employed of the undiluted vaccine. It is evident, therefore, that the amount of active principle present in ordinary vaccine is far in excess of what is necessary. That being the case the amount of available fluid is multiplied by fifteen, and to that extent the production of a good supply of trustworthy calf lymph is facilitated, and it becomes a comparatively easy matter to supply a pure lymph at a small cost. Hitherto at the animal vaccine establishment in Lamb's Conduit Street the amount that could be obtained from a single calf was, at the outside, only sufficient for the vaccination of some 200 to 400 patients, and this had to be done under somewhat unfavourable conditions—namely, directly from the calf to the arm of the patient—in order that there might be as few organisms in the lymph as possible, as naturally any organisms would multiply comparatively rapidly in stored lymph to which antiseptics could not be added. With the lymph from a single calf, used according to the new method, 4000, 6000, or even 15,000 vaccinations may be carried out, of course not at once from calf to arm, as the lymph may be kept under observation for some time, during which test-plate cultivations may be made, and the presence or absence of micro-organisms demonstrated. The glycerine does not kill certain organisms instantaneously. Consequently test-plates, made immediately after the emulsion has been prepared, may

contain a number of organisms. In such a case the vaccine would be left to mature—*i.e.* to get rid of these organisms—which it will do in a few days at the outside. As soon as such organisms can no longer be demonstrated in plate cultures, or as soon as the exact period at which they disappear has been absolutely determined, the glycerinated vaccine may be used by the operator, who may have full confidence that no secondary or untoward conditions, which can in any way be attributed to impurity of the vaccine lymph, will arise.

In view of these facts, and of the splendid results that have been obtained in Paris, Brussels, Berlin, Cologne, Dresden and Geneva—the vaccine Institutes in which cities were specially visited and reported upon by Sir Richard Thorne Thorne and Dr. Monckton Copeman—and in view, also, of the recommendation of the Royal Commission on Vaccination, all who take an interest in this question (and the number of these is far greater than many people imagine) will hail with delight any measure brought forward by the Government to facilitate the preparation and encourage the use of glycerinated calf lymph, especially wherever it is found necessary to apply the compulsory clauses of the Vaccination Act, and also for vaccination generally.

Perhaps one of the main advantages adduced in favour of vaccination with calf lymph is that the animals may in the first instance be carefully selected, so that only such as are of sound constitution and good family history need be employed; but even then, under the old system, owing to the outlay involved if the calves were killed at once and not used for food, a post-mortem examination could not be obtained, or thorough inspection of the organs made. It was, therefore, not possible for the vaccinating officer to state that there was no disease in the animal. Now that such a large amount of lymph can be obtained from a single calf, it would scarcely be justifiable to neglect this post-mortem inspection; consequently, as the lymph should not be used for a few days after it has been taken and made into an emulsion, the medical officer is able to assure both himself and his clients, that the animal from which the special lymph he is using has been taken is absolutely free from flaw or blemish, whilst the after-treatment of the lymph with glycerine enables him to certify that the effects of accidental contamination from outside are completely neutralised.

It is somewhat humiliating to us as a practical nation to find that a method worked out theoretically by an Englishman should have received attention, and been applied practically in almost every important European country before it has been thought necessary to draw attention to it at home. Still, we are glad that at last Government has been brought to see its duty in this matter, and to make preparations for acting up to the light it has received.

For the information of our readers we may quote Sir Richard Thorne Thorne's conclusions, drawn up after visiting the establishments to which reference has already been made:—

"(1) It is desirable that vaccination, both primary and secondary, carried out under the auspices of the Government, should be performed exclusively with vaccine lymph direct from the calf.

"(2) There will probably be advantage in retaining, for a time at least, the system of calf-to-arm vaccination at the Board's Animal Vaccine Station for such parents and others as may specially desire it, and for the purposes of comparing its results with those following the use of calf lymph preserved in one or another way.

"(3) The distribution of calf vaccine from the National Vaccine Establishment should be limited to glycerinated or similar preparations of lymph and pulp material, in air-tight tubes, or other glass receptacles.

"(4) To give effect to the above it will be requisite that the Board's Animal Vaccine Station should be reorganised, both as regards construction and administration. Notably will it be requisite that it should include a properly equipped laboratory, under the direct supervision of a bacteriological expert."

It is to be hoped that in any legislative measure which may be formulated and passed, due effect will be given to each of these four conclusions, although from many points of view it would appear desirable that the second recommendation should be made to cover a comparatively short period, as most people who have studied the question are now fully of the opinion that calf-to-arm vaccination has no advantages over vaccination with glycerinated lymph, and few parents who are likely to express any opinion at all, may be expected to ask for calf-to-arm vaccination of their children.

We look upon this document as one of the most important that has been published from the Department for some time, and we heartily recommend a perusal of its contents to those who are in any way interested in the study of the vaccination question.

NOTES ON SOME VOLCANIC PHENOMENA IN ARMENIA.

As we descended from the central mountains of Armenia towards the south along the road from Akstafa to Erivan, we suddenly came upon a beautiful sheet of water lying glassy and restful in the lap of the mountains. Those on the left, sloped down to its shore with every diversity of valley, creek and headland, and with gently moulded outlines which told of subaerial waste, and gave the impression of a mountain land the base of which the waters had but recently begun to bathe. From the heights on which we stood the lake seemed to follow a somewhat narrow sinuous course, which suggested the idea that we were looking on a dammed-up valley. But it could not be the submerged end of a long valley invaded by the sea, for we were still between 6000 and 7000 feet above sea-level. On the right, beyond the lake, conical hills, often nicked at the summit, with long ridges radiating from them, rose in strong contrast to the more ancient rocks of the northern slopes, and suggested plainly by their geographical outline a volcanic region which had been so recently active that there had not yet been time for its distinctive features to have been obliterated.

Soon we wound our way round the north-western end of the lake, and found that we had to cross its principal outlet, and then immediately descend rapidly into the valley of the Araxes. Here, then, we might hope to see some reason for this strange holding up of such a vast body of water on the edge of the mountain land.

As we turned round to the right beyond the little village of Elenofka we found the passage barred by long moraine-like ridges. We had just seen snow-covered summits and glaciers in the Caucasus, a little further north, and moraines, telling of the former much greater extension of those glaciers. We asked ourselves whether similar conditions might not have produced glaciers and moraines here also on the slopes of the Armenian mountains? But when we reached the first of the ridges we found that it was not a moraine at all, but a lava-flow with scoriaceous surface and more solid rock within. The stream with its equalised flow had cut but a very small gap in these barriers, one after another of which had been thrown forward, and had built up a mass which, from the physical geography of the country, we inferred must be thousands of feet in thickness. What the depth of Lake Gokcha was we were not able to ascertain, but it runs for forty-three miles along the base of the mountains and widens out in places to a breadth of twenty miles. To save room our diagram (Fig. 1) is taken across the narrow western end, so that it does not indicate the proportion this enormous body of water bears to the size of the valley

below. Should that lake by any great shock be suddenly let out—not an improbable catastrophe—what a terrible deluge would sweep the plain of the Araxes; and, if the lake were wholly or partly drained, what a history of the gradual heaping up of waters on the flanks of an active volcanic region might be studied in its depths.

Here we saw not a mountain valley dammed, but the whole foot of a mountain region enclosed by volcanic

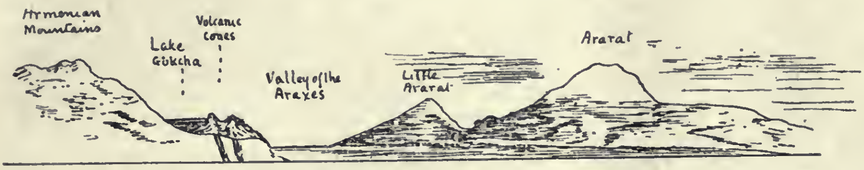


FIG. 1.—Diagram to explain the mode of occurrence and origin of Lake Gokcha.

ejectamenta having their origin along a belt of country lying a little off and in front of the high ground. From this the inference is obvious that the outlet was not always where we crossed it, and we were therefore prepared to find here and there curious conditions of the rock pointing to a different line of exit for the percolating and overflowing water.

What struck us most in examining the outflowing stream at Elenofka was its very small volume considering the extent of the lake that feeds it, and we could see no evidence of any considerable difference of level between the late summer's flow and the winter's flood waters. The stream filled its channel up to its reedy green bank, and no bare beds of sand and gravel or heaps of torrent débris suggested that it ever rose any higher. Perhaps when the waters do rise, they find their way through broken or scoriaceous rock to other outlets.

Driving on through ridge and tumbled crag of brown and black cindery rock—the great barrier of lava that holds back the lake—we suddenly came to the southern flank. We looked out through an opening in the lava over the rich valley of the Araxes, and first caught sight of Ararat rising grandly alone into the soft southern sky. Distance did not dwarf its 17,000 feet; but whether it was active at the same time that the Elinofka volcanoes were locking up Lake Gokcha, I cannot say. Perpetual snow now covers this hill of ancient fires. There it has stood for ages, looking down on the region where tradition carries us back to the earliest homes of civilised man.

As we descended from the great masses of lava around Lake Gokcha, we suddenly came upon a most interesting and suggestive section, where the road winds under a cliff, partly natural and partly cut back for the road itself, so as to exhibit now a face of newly-bared rock. In this we saw alternations of dark green or brown-black obsidian, and a white product of decomposition of volcanic rock standing in vertical planes (see Fig. 2). The white rock is, especially in the upper part of the cliff, apt to be broken up into a kind of breccia made up of pieces of all sizes and shapes. The first impression produced by the section would be that it consisted of a number of bands of obsidian alternating with a coarse agglomerate of fragments of one and the same kind of decomposed igneous rock, and all turned on end by subsequent movement. But an examination of the ground soon showed that view to be untenable, because the section was cut through the terminal margin of a lava-flow which had come down from the great volcanic group forming the southern rim of Lake Gokcha (see Fig. 3, in which the arrow indicates the direction of flow). The obsidian bands are therefore at right angles to the bedding.

Another view was therefore suggested, namely, that the obsidian was injected or found its way along vertical fissures in the crushed and brecciated rock of an earlier flow. But had this been so, there seemed no reason to limit the injection to the vertical planes. The molten liquid mass would have penetrated in all directions through the fractured rock. Besides, an examination of the rock in detail showed that the obsidian was not injected, for it occurred in isolated masses in the midst of the white porcelanous or powdery rock. The plates assumed a fan-shaped arrangement in places, as if their position had been determined by joints converging down-

FIG. 2.

wards. The mode of occurrence of the rock suggested the true explanation of the phenomenon. The white rock was decomposed obsidian. The whole mass was a quickly cooled lava traversed by shrinkage joints at right angles to the cooling surfaces, and roughly parallel to the line of flow. Water followed the cracks, acted on the silicates, and changed the glassy lava to the white chalk-like mass in which bands of obsidian, preserved between

FIG. 3.

the joints, still remained samples of what the whole rock once was.

A similar change may be observed at Obsidian Cliff in the Yellowstone Park in America, where the same alternation of bands of decomposed and sound obsidian may be seen as in the Armenian section, though not on such an extensive scale. The same process picks out by decomposition the spheroidal shells, which are

invisible in the sound part. An analogous process may also be seen in the grand cañon of the Yellowstone River, where the rhyolites have been weathered into a white or yellowish, mealy-textured rock along the great fissure, which allowed a freer passage to, and still emits, in diminished quantities at the bottom of the gorge, heated water and steam from the dying-out volcanic furnace below.

So along the Armenian lava-flow water easily got in from the surface, or followed the longitudinal cracks in the rapidly cooled rock, and, being itself heated by the process, acted upon the silicates, and carried off the more soluble portions. A diminution in volume accompanied the process, and the reduced rock broke up.

May be the old valley down which this lava flowed was an ancient outfall of Lake Gokcha before its rim had been built up as high as it now stands. Perhaps at one time some of the water of the lake found its way through fissured masses to lower levels, and carried on the work of destruction within the rock itself.

We want many more facts respecting this most interesting district—we would like to know the depth of the lake, the direction of any observed lines of fissure, and if there is any evidence of the waters of the lake having ever been suddenly drained off into the valley of the Araxes. We hope, therefore, that Mr. Loewinson Lessing, whose knowledge and skilful arrangements enabled us to see so much of the district, and whose courtesy and thoughtfulness made our excursion so pleasant, may be able to carry on the work for which he is so well qualified, and will communicate to the world the result of his further investigations.

T. McKENNY HUGHES.

PERIODIC ORBITS.

FOR some years past, Prof. G. H. Darwin has been engaged on the numerical solution of a particular case of the problem of three bodies, and at different times he has given some account of the progress he has made. He has now collected his very extensive material, relating to both the mathematical methods employed and the discussion of the numerical results, into one compact summary under the title of "Periodic Orbits," which appears in *Acta Mathematica*, vol. xxi. The special case treated by Prof. Darwin refers to one of three classes into which M. Poincaré has divided the periodic solutions of this problem. In this class, the motion is entirely in two dimensions, and the excentricity of the planet's orbit is very small; but Prof. Darwin further supposes the perturbed body to have infinitely small mass, and the planet's orbit to be absolutely circular. The discussion of even this one class has had to be restricted in the course of the work, on account of the heavy arithmetical labour which the method of tracing the orbits by mechanical quadratures involved. Retrograde orbits have not been considered, and the motion of superior planets is still engaging Prof. Darwin's attention. Some thirty examples of periodic orbits have, however, been examined; and though the author may speak of his results very modestly, there is no doubt but that his conclusions will be welcomed as a most interesting contribution to the study of celestial mechanics.

Prof. Darwin defines a periodic orbit as one in which a third body can continually revolve so as always to present the same character relative to the two other bodies of the system. These orbits are not necessarily confined to a single revolution round the primaries, or round any other point in space, but the difficulty of the determination of the path increases with the number of circuits described, and on that ground the present treatise is confined to the examination of "simple periodic orbits," or those which are re-entrant after a single circuit, though loops may, and do, occur in the orbit. In the system considered, the distance between the sun and the principal planet, here called Jove, is taken as unity, and the ratio of the mass of the sun to that of the planet as 10 : 1. This hypothesis differs considerably from the actual circumstances prevailing in our system, but it offers the advantage of exaggerating all the phenomena of perturbation, and permits the clear exhibition of the deductions in diagrams that are easily appreciated. Some of the stellar systems may offer conditions more nearly parallel to those here assumed. A looped orbit has been suggested in the case of one of the components of ζ Cancri, though possibly with insufficient data, and in some other cases, the presence of a disturbing body seems likely to produce an orbit of very irregular form.

We have accustomed ourselves to consider the relations of superior and inferior planets and of satellites to be fixed and definite, but Prof. Darwin traces the conditions under which these forms cease to be permanent, and when consequently the third body of a system can assume the characteristic motion of either an inferior planet or a satellite. With a particular value for the constant of relative energy, it is possible for both kinds of planetary and satellite motion to become confused, and for a body which originally started in one way to exhibit the peculiar motion of either of the other two. Prof. Darwin began his numerical work by an assumed case in which it was possible for an inferior planet and satellite to interchange their parts. The satellite was made to start at right angles to a line joining the sun and Jove, at a distance of 1·08 from the sun, Jove's distance being unity. The resulting orbit is fully drawn and shows how the body hangs in the balance, between the two centres, before the elliptic form of the orbit asserts itself, as the body approaches the sun. Starting the satellite from a conjunction remote from the sun, but at slightly different distances from Jove, it is found that the resulting orbits show a great diversity of character, which cannot always be foreseen. Perhaps the most remarkable curve in this family arises when the satellite starts at a point 1·095 from the sun. After making a loop, the satellite recrosses the line of conjunction and moves directly towards the planet, so that it is impossible to determine its subsequent path without very accurate computation. "I do not think," says Prof. Darwin, "any one could have conjectured how the body should have been projected so as to fall into Jove." The positions which give rise to periodic orbits are shown by the distances from the sun at which the curve meets the line of conjunction after one complete circuit. If for two selected points of projection, the curve returns to this line at places alternately nearer to and more remote from the sun than those from which it originally started, then there must be some point intermediate between these selected points at which the curve will be re-entrant. Other forms of orbits giving rise to distinct families, have been computed, and drawn, when the satellite is projected from points intermediate between the sun and Jove, and also from conjunction on the side remote from Jove. Most of these orbits do not possess the character of stability, a point which the author has considered with as much care as the form of the orbit itself. It has been questioned whether all orbits are not essentially unstable, if the number of revolutions be sufficiently great. The result of the present investigation is to show that orbits may be stable if the perturbation of Jove by the planet can be neglected. This is the only approximation that Prof. Darwin has permitted himself, and he remarks "that for a very small planet the instability must accordingly be a very slow process, and I cannot but believe that the whole history of a planetary system may be comprised in the interval required for the instability to render itself manifest."

WOLDEMAR VON SCHRÖDER.

HEIDELBERG has had to mourn the loss in rapid succession of three of its most distinguished professors—Victor Meyer, Erwin Rohde and, on January 28 of this year, Woldemar von Schröder.

Schröder was born at Dorpat in 1850, where his father was director of the Gymnasium. On his mother's side he inherited a taste for literature and poetry, but on entering the University at Dorpat, in 1868, he devoted himself to the natural sciences, possibly influenced thereto by his uncle, von Schrenk (of St. Petersburg), who was celebrated for his journeys and researches in Siberia. At first he studied chiefly chemistry and physics under Karl Schmidt and Arthur von Oettingen, and trained himself under Lemberg to that high pitch of analytical skill which he manifested in all his later work. After a break in his studies, due to persistent pains in the head and trouble with his eyes, he again returned to work; now, however, turning his attention rather into a biological direction. In 1878 he left Dorpat with the degree of Master of Chemistry, and went to Leipzig, where he was at once attracted by the striking originality and personality of Karl Ludwig, and in his laboratory saw for the first time the perfection of physiological experimenting. But Schröder was one of the few who were not content to learn by merely assisting Ludwig in personally carrying out all the experiments, and he struck out into paths of his own. Skilled as a chemist, he soon became an expert operator, and succeeded for the first time in successfully extirpating the kidney in birds, and thus settling a most important question as to the seat of formation of uric acid. In 1879 he became assistant to Schmiedeberg in Strassburg, and here it was that he carried out the great research with which his name will for all time be connected in the annals of physiology. Very little was at that time known as to the mode and seat of formation of urea, and Schröder threw a flood of light into the darkness. Having by extirpation of the kidneys, and artificial circulation through the excised organs, proved that urea is not formed by them, he next carried on an artificial circulation of blood containing ammonium carbonate through the muscles, and found that in them also no synthetic formation of urea takes place. He now turned to the liver and, again making use of artificial circulation, proved without any possibility of doubt the power of this organ to actively synthetise urea from ammonium carbonate and from certain substances present in the blood from an animal in full digestion. This was a great work, for not only did it reveal clearly a striking instance of synthetic activity in the animal organism, and thus place our belief in the fundamental similarity of plants and animal protoplasm on a firm basis, but it fixed definitely one seat of formation of urea in the animal body. In recognition of this work he received the degree of Doctor from the Natural Science Faculty of Tübingen in 1882, and similarly, and in the same year, he was made a Doctor at Strassburg, where he became Privat-docent in 1883. For this he wrote his inaugural dissertation on the alkaloids of opium, and thus diverged into that branch of science, pharmacology, which was henceforth to be the business of his life. During the next few years his chief works were on the physiological action of caffeine and of theobromine as related to caffeine, while at the same time he converted theobromine into a more soluble and assimilable compound, making it thus available for medicinal purposes. In 1890 Schröder was called to Heidelberg as Professor of Pharmacology, and he it was who really founded the existing Pharmacological Institute, turning the older accommodation to the best account, utilising or enlarging every corner of it, and completely remodelling and organising the teaching. Here he worked until his death, stimulating his pupils by his personal example and collaboration, brightening their labours by his sympathetic and genial ways, and impressing on all the right spirit of scientific life.

THE KEKULÉ MEMORIAL.

THE death of August Kekulé on February 13, 1897, terminated a career rich in scientific achievement. In him we have lost an investigator who has exerted a profound influence on the development of chemistry.

The theory of valency and of the linking of atoms, and our present views as to the structure of carbon compounds, have acquired their definite form and clearness by the labours of Kekulé. His theory of benzene derivatives, in particular, has given the most powerful impulse to investigation in the domain of pure chemistry; while no scientific theory has done more to promote the development of chemistry as a branch of industry. While Kekulé is eminent by his scientific achievements, he is not less so by reason of the effects produced by his teaching. The publication of his "Lehrbuch der Organischen Chemie" marked an epoch in the history of chemistry. This treatise has done more to familiarise chemists with modern views than any other work of the kind.

The greater number of German professors of chemistry, and many of those in other countries, have either studied under Kekulé or under those who were his pupils: and gratitude calls for the erection of some permanent memorial of his striking personality.

Such a memorial would be a statue in bronze of the founder of structural chemistry, which would be fitly placed in front of the Chemical Institute at Bonn—in the place where for thirty years he lived and taught and worked.

All friends, admirers and pupils of Kekulé are accordingly invited to contribute to this object. Subscriptions, which will be forwarded to the Central Committee at Bonn, will be received by Dr. Hugo Müller, 13 Park Square East, Regent's Park, N.W.

JAMES DEWAR.	HUGO MÜLLER.
G. CAREY FOSTER.	FRANCIS R. JAPP.
T. E. THORPE.	RAPHAEL MELDOLA.

NOTES.

ACTING under the rule which empowers the annual election by the Committee of nine persons "of distinguished eminence in science, literature, the arts, or for public services," the Committee have just elected Viscount Dillon (president of the Society of Antiquaries), Mr. R. T. Glazebrook, F.R.S., and Sir George Scott Robertson into the Club.

THE meeting for the discussion of the scientific advantages of an Antarctic expedition takes place at the Royal Society this afternoon. We purpose giving a full account of the meeting in next week's NATURE, accompanied by a map showing all known land south of latitude 45° S., with drift and pack ice limits, so far as known, and the positions and dates of the highest latitudes reached.

THE Berlin correspondent of the *Standard* reports that the German Antarctic Expedition Committee, which met at Leipzig on Saturday last, unanimously resolved, after a long discussion, to advocate the despatch of a ship towards the South Pole on or near the meridian of the island of Kerguelen. Oceanic, geodetic, and biological researches are to be made during the voyage, and, if possible, the expedition will winter in the Antarctic zone. In that case geological observations are to be made at a fixed station, and exploring journeys on the inland

ice and to the unknown west coast of Victoria Land, discovered by Sir James Clark Ross, will be undertaken in the spring. The return of the expedition, which will last two years in all, and will make observations on the home voyage as well as on the way out, will take place in the southern autumn. Dr. Erich von Drygalski, well known as an explorer of Greenland, was appointed the scientific head of the expedition.

Lord Lister is suffering from a severe cold, and was prevented by it from occupying the chair at Dr. Nansen's lecture on Monday.

We are glad to see the announcement that Sir Richard Quain's strength has so far improved that no further official bulletins will be issued.

The Pasteur Institute at Paris has received a donation of 1600*l*. from Mme. E. Durand, for the purpose of carrying on investigations on tuberculosis.

The personal estate of the late Mr. J. W. Zambra, formerly of the firm of Negretti and Zambra, the well-known philosophical instrument makers, has been valued at 176,075*l*.

The fifth International Congress of Hydrology, Climatology, and Geology will be held at Liége this year, from September 25 to October 1, under the patronage of His Royal Highness Prince Albert of Belgium.

The Physical Society of Frankfort-on-Main propose to erect a monument to Philipp Reis, the inventor of the telephone, and have appointed a committee to obtain subscriptions for this purpose. The estimated cost of the memorial is 1500*l*.

The fourteenth International Horticultural Exhibition is to be held at Ghent from April 16 to April 24 next. This exhibition, which takes place every five years, is organised and managed by the Royal Society of Agriculture and Botany at Ghent. It is under the patronage of the King and Queen of Belgium, and is subsidised by the national, provincial, and municipal Governments.

H.R.H. the Prince of Wales has consented to open the International Photographic Exhibition at the Crystal Palace on Monday, April 25, and not Wednesday, April 27, as originally announced. The latest date for the reception of exhibits in each section will therefore be two days earlier than that first stated on the prospectus.

At the meeting of the Physical Society of London, to be held at Eton College on Saturday, February 26, the Rev. T. C. Porter will exhibit and describe several interesting experiments. The subjects with which he will deal are: (1) a new theory of geysers; (2) a new method of viewing Newton's rings; (3) experiments bearing on the sensation of light; (4) a method of viewing lantern projections in stereoscopic relief; (5) winter observations on the shadow of El Teide, with a new method for measuring approximately the diameter of the earth; (6) temperature of the water of Niagara.

The death of M. Gauthier-Villars was referred to, with expressions of regret, at the meeting of the Paris Academy of Sciences on February 7. Since 1835 the *Comptes rendus* of the Academy have been printed by the firm of Gauthier-Villars, and, in spite of the large quantity of matter on a variety of subjects, and the idosyncrasies of authors, the hour of publication has never been delayed. The firm has published for many years the publications of the Bureau des Longitudes, those of the Paris Observatory, and of the Bureau Central météorologique. M. Gauthier-Villars also assisted the French Government and the Academy in the publication of the complete works of Lagrange, Fermat, Fourier and Cauchy, and his name is associated with many other scientific enterprises.

The anniversary meeting of the Geological Society was held on Friday last. Mr. W. Whitaker, F.R.S., was elected president in succession to Dr. H. Hicks, F.R.S., whose presidential address appears in another part of the present issue. The new vice-presidents elected are Prof. J. W. Judd, C.B., F.R.S., and the Rev. H. H. Winwood. Prof. W. W. Watts has succeeded Mr. J. E. Marr, F.R.S., as secretary, the other secretary being Mr. R. S. Herries. To the list of members of Council were added the names of Dr. G. J. Hinde, F.R.S., Mr. W. H. Hudleston, F.R.S., Prof. H. G. Seeley, F.R.S., Prof. W. J. Sollas, F.R.S., and Mr. A. S. Woodward. The medals and prize-funds were awarded to the geologists whose names have already been announced (p. 252).

Surgeon-Major Black, Edinburgh, has received a letter from Mr. C. L. Wragge, dated Sydney, January 7, referring to a new high-level meteorological station. In the course of the letter Mr. Wragge says:—"You will be pleased to know that I have quite successfully established a mountain experimental observatory on the summit of Mount Kosciusko 7328 feet above sea-level, and the highest point in all Australia; also a sea-level station on the south-east coast adjacent at Merimbula, where simultaneous observations are taken. The hours are midnight, 4 a.m. and 8 a.m.; noon, 4 p.m. and 8 p.m.; also half-hourly from 8.30 a.m. to 11.30 a.m. inclusive. Simultaneous readings are also taken at a new station in Sydney, at Sale in Victoria, and at Hobart, and on Mount Wellington, Tasmania."

The meeting, held in the rooms of the Manchester Literary and Philosophical Society on February 16, to consider what should be done to assist in making the forthcoming Congress of Zoology a success, was well attended by representatives of various natural history and scientific societies in the centre and north of England. Mr. J. Cosmo Melvill presided. Prof. S. J. Hickson explained to the meeting the objects of the International Congress of Zoology and the probable programme of the week in August at Cambridge. The following resolution was then proposed by Mr. Masefield, president of the Conchological Society, and carried unanimously:—"That this meeting of persons resident in the centre and north of England, and interested in zoological progress, offers its most cordial support to the Committee now organising the fourth meeting of the International Congress of Zoology, to be held in Cambridge in the last week of August, and expresses a sincere hope that all societies instituted for the study of zoology and kindred subjects will contribute in accordance with their means to the funds of the Congress, and appoint one or more representatives from their members to attend the Congress." The delegates at the meeting were enthusiastic about the Congress, and their cordial co-operation will encourage as well as assist directly the work of the Executive Committee.

At its annual meeting on February 2, the Russian Geographical Society awarded a special Constantine medal to Dr. Nansen; a Constantine medal to V. I. Robcrovsky, for his journeys in Central Asia; the Count Lütke's medal to I. I. Strelbitzky, for his journeys in Persia and Manchuria in 1891–96; the new Semenoff's medal to Dr. Sven Hedin, for his three years' journeys in Central Asia. A large gold medal of the Society was awarded to I. K. Zhdanoff, for his ethnographical works, and especially for his work on "Russian Epical Poetry"; and small gold medals to Th. Witram, for pendulum measurements in the Far East; to F. Sperck, for his large work on the climate of the Astrakhan region; to S. Rybakoff, for the collection of specimens of musical texts of songs amongst the Ural natives; and to S. Gulishambaroff, for his work "The World's Trade in the Nineteenth Century and Russia's Part in it." Silver medals were awarded to MM. Pastukhoff, for his ascension of the Elbrus; Abels, for hypsometrical measurements in the Urals;

B. A. Fedchenko, for a communication on the Talas Alatau; Timonoff, for a paper on the water-communications on the tributaries of the Amur; Sapozhnikoff, for work on the glaciers of the Altai; Kovanko and Semkovskiy, for the organisation of international balloon ascensions in which the Society took a part; and to Prince Obolensky, Tomilovskiy and Utyesheff, for their daily observations upon the motion of the clouds.

MR. LEONHARD STEJNEGER, of the U.S. National Museum, paid another visit to the Russian Fur-seal Islands (Commander Islands) in the Northern Pacific, last year, by order of the U.S. Government, and has just issued his report (Treasury Department, Document No. 1997). The examination of the "Rookeries" was made mostly in company with one of the British Commissioners, Mr. Barrett-Hamilton, and appears to have been a work of some difficulty and danger, owing to the wild weather generally prevalent, and the utter absence of means of communication. Mr. Stejneger's general conclusions demonstrate "a very great decrease in the breeding females" of the Fur-seals since 1895, when he made his last official report (U.S. Fish-Commission, *Bulletin* for 1896, Article 1). He also alleges "great mortality in the pups, due to starvation." He comes finally to the conclusion that a *zapuska*, or total prohibition of killing seals on land for a period of years (which he formerly advocated), would be rather an injury than a help to the seal-herds, as it would "increase the number of superfluous bulls."

SINCE he succeeded Sir Harry Johnston as Commissioner and Consul-General of Nyasaland, Mr. Alfred Sharpe has not ceased in the good work carried on so long by his former chief, of collecting and sending home examples of the fauna and flora of that Protectorate. Mr. Sharpe is now on his way home on leave, much impaired in health, we regret to say, from his long stay in the tropics, but brings more collections with him. A memoir, by Mr. Thomas, on the mammals procured by Mr. Sharpe, will appear in the next part of the Zoological Society's *Proceedings*, and Captain Shelley is at work on the birds obtained by this energetic administrator.

THE colonial report on "Cocos-keeling and Christmas Islands," 1897 (c.-8650-14) contains a few useful natural history and other notes. A small brilliant red crab is frequently seen up the hills, running in and out of holes or from under stones. Once a year, in the month of December or January, the male and female travel down to the sea margin, where the female deposits her eggs, and the parents again return. They take fifteen days going and fifteen days returning, and travel in bodies like ants. After the eggs are hatched, the young, when big enough, move up the hill. Darwin doubted whether the crab climbed trees; but it is now a well-ascertained fact, though the purpose is still unknown. Both Mr. Forbes and the reports of H.M.S. *Challenger* describe the white tern or noddy as a beautiful bird with black eyes; but no mention is made of the beautiful purple-blue of the beak up to the nostril, the feet and the tarsus. This is probably due to the fact that two or three hours after the birds are shot the colour of the beak and feet die away. A short description of three native dances is also given.

PROF. J. C. EWART, F.R.S., contributes to the *Zoologist* an illustrated article upon zebra-horse hybrids. His experiments prove that it is a comparatively simple matter to cross various breeds of mares with a Burchell Zebra, and, if experts are to be trusted, the hybrids promise to be as useful and hardy as they are shapely and attractive. The preliminary difficulties having been overcome, Prof. Ewart points out that it remains for those in authority to take such steps as may be necessary to ascertain of what special use, if any, zebra hybrids may be in the various parts of the Empire, but more especially in Africa and India.

A SNOWSTORM of considerable severity occurred over the south-western districts of England during Monday night, the snow gathering to a considerable depth in places, and causing much inconvenience and delay to ordinary traffic. In parts of Devon, Somerset and Dorset, the drifts were several feet deep. At Hurst Castle, Hants, a reporting station of the Meteorological Office, the melted snow and sleet measured 1·6 inches of water. Thunder and lightning were also experienced during the storm. This disturbed weather was occasioned by the arrival of a shallow cyclonic area over the south-western portion of our islands, which lingered in those parts during Monday and Tuesday.

THE U.S. *Monthly Weather Review* for November last contains an account of the celebration of the fiftieth anniversary of the establishment of the Royal Meteorological Institute in Berlin, on October 16, 1897. The jubilee festivities were divided into three parts: an address in the Memorial Hall of the Royal Geodetic Institute, an inspection of the magnetic and meteorological observatories of the Institute, and a banquet. The high recognition given in Germany to meteorological science was evidenced by the presence of the Emperor and Empress, who were accompanied by a brilliant retinue, and listened to the address of Dr. v. Bezold, the Director, who sketched the activity of the institution during the whole period of its existence. At the present time the organisation consists of 188 stations for regular observations, 1336 thunderstorm stations, and 1844 rainfall stations. Various experimental investigations are conducted at the Potsdam Observatory, and, owing to the generosity of the Emperor, scientific balloon ascents on a large scale are occasionally made for the study of the physics of the upper air. At the close of the address, the Minister of Education announced certain decorations to be given in connection with the celebration. The great gold medal in science was presented to Dr. v. Bezold, and Orders of the Crown or of the Red Eagle were presented to Dr. Hellmann, Dr. Sprung, Dr. Vogel, and to Herr Treitschke, proprietor of the observatory on the Inselsberg, near Erfurt, and to various other scientific men. Numerous addresses and telegrams of congratulation were received from all parts, including one from the Grand Duke Constantine, on the part of the Imperial Russian Academy of Sciences.

IN his "Twelfth and Concluding Memoir on the Theory of Screws," published in the *Transactions of the Royal Irish Academy*, Sir Robert Ball completes the solution of a problem which has for the past five-and-twenty years been associated with his name. A feature of his paper is the series of summaries of this and the eleven preceding memoirs, and we feel that we can do no better than quote in his own words Sir Robert Ball's summary of his latest investigation: "At last I succeeded in accomplishing what I had attempted from the first. I could not develop the complete theory, which I felt certain must exist, until I had obtained a geometrical method for finding the instantaneous screw from the impulsive screw. When this was accomplished in the midsummer of 1897, the geometrical theory in Dynamics, which I had striven for a quarter of a century to obtain, was at last manifest. How my difficulties were overcome has been set forth in this Memoir. There are, no doubt, many other questions that would repay investigation at almost every stage of the subject. But the problem which I had proposed to myself so many years ago, and which I have steadily kept in view ever since, having been at last resolved, I have felt that this series of papers should cease."

MR. E. CHARLES HORRELL, writing in the *Journal of Botany* for February, invites the co-operation of bryologists in working out the comital distribution of British mosses in the way that the distribution of flowering plants was done by Watson. With the object of seeing how far the lists of mosses already published

would enable him to compile a census of the 112 Watsonian vice-counties, the writer has looked through most of the magazines, county floras, proceedings of local natural history societies, the Botanical Record Club's Reports, &c., in the library of the British Museum, and he finds that fairly good lists have been published for about fifty vice-counties; there are, therefore, about sixty-two vice-counties in Great Britain for which he can find no lists of the commoner mosses. Mr. Horrell has already received lists or offers of assistance from correspondents in about thirty-four vice-counties, but would much like to find a moss student in each vice-county who would undertake to prepare a list of his district during the next two or three years. Mr. H. N. Dixon and Mr. E. M. Holmes have offered their aid in examining doubtful or critical species. Mr. Horrell's address is 44 Brompton Square, London, S.W.

IN a contribution to the *Transactions* of the Nova Scotia Institute of Science, ix., Mr. E. H. Archibald describes a series of determinations, made at Dalhousie College, of the conductivity of aqueous solutions containing potassium and sodium sulphates. The object was to ascertain if the conductivity was calculable in the case of mixtures of these solutions from the formulæ given by the dissociation theory of Arrhenius and others. It would appear that for mixtures of solutions of these salts, not more concentrated than 0·8 equivalent gramme-molecules per litre, it is possible by the aid of the dissociation theory to compute the conductivity within, or but little beyond, the limits of the error of observation. For more concentrated solutions the differences between the calculated and observed conductivities ranged up to 1·47 per cent.; but this discrepancy seems attributable, in part at least, to certain asssumptions regarding the ionisation-coefficients, which could not be regarded as rigorously correct, except at infinite dilution.

MESSRS. MACMILLAN AND CO. will publish in a few days the first volume of a comprehensive treatise on "Magnetism and Electricity," by Prof. Andrew Gray, F.R.S. In this work an attempt has been made to present the subject from the beginning from the point of view of action in a medium, and to bring the experimental and theoretical results described as far as possible down to date. The present volume, though it takes for granted a knowledge of some of the most elementary phenomena and apparatus, aims at giving an account of experimental work as well as of the related magnetic or electric theory. It includes the ordinary phenomena of magnetism and their theory, a discussion of electrostatics and of steady flow of electricity, of electromagnetism and of the electromagnetic theory of light. The treatment is as far as possible dynamical, and to facilitate reference to dynamical theorems, a chapter on general dynamics has been included in this first volume. In Volume ii. will be given, among other matters, an account of experimental work on magnetism, of recent work on Hertzian, Röntgen, and other radiations, and of general dynamical theories of electromagnetic action, a continuation of the discussion of the voltaic cell begun in Volume i., and a chapter on electrolysis.

THE Mexican Scientific Society, which is called "Antonio Alzate," is doing excellent work, to judge from the recent numbers of its *Memorias* which have reached us. Among other papers we find seismic observations at Orizaba, by M. C. Mottl; physico-chemical studies on the fat of the Yoyote shrub (*Thevetia yecotli*), by Prof. Villaseñor; on the decimalisation of the circle and of time, by M. J. de Mendizábal-Tamborrel; on the concentration of auriferous and argentiferous minerals, by T. L. Laguerenne; on the augmentation of weight of tuberculous and anæmic patients in rarefied air, by Dr. D. Vergara Lope; studies on the transpiration of Mexican plants, by Prof. L. G. Seurat; on the syrup of iodide of iron, by Prof. F. Solórzano; on orogenic movements, by M. P. C. Sánchez; on the temperature of plants, by MM. Moreno and Anda; measurement of the tension of the blood of the dog, by Dr. D. Vergara Lope; and formulæ for the velocities and pressures in guns, by M. F. Angeles; as well as reviews of books, &c. The Society, besides publishing these *Memorias* in a convenient size for binding up with the majority of octavo scientific papers, has adopted the excellent plan of beginning each paper on a right-hand page; any specialist can thus bind up separate papers on selected subjects without impairing the rest.

A RECENT number of the *Cape of Good Hope Agricultural Journal* contains an article on "The serum method of treating cattle as a preventive of rinderpest in South Africa," in which the joint report of the French experts and the Government Veterinarian is given *in extenso*. It contains rules for the application of the method of treating cattle by the injection of protecting blood, and attention is called to the importance of procuring the blood from animals which have suffered from rinderpest in its most severe form, and which have been "salted" or rendered immune to the disease one to five months previously, and have received at least one injection of rinderpest blood. It is urged that general measures should be taken throughout the whole of South Africa to prevent the spread of rinderpest, the protective measures already adopted by the Governments of the South African Republic, Orange Free State, and the Cape Colony have had some good effect, but it is feared that unless further and more vigorous steps are taken, the epidemic will conquer the whole of South Africa. If we consider that it was in the beginning of the year 1896 that rinderpest first made its appearance in Matabeleland and Mashonaland, and in less than eighteen months had destroyed all the cattle of these two countries, and had also overwhelmed the territory of the South African Republic and the Orange Free State, the necessity for united and strong action appears sufficiently imperative. It is at present, the report tells us, spreading from north to south, and from east to west, and seriously threatens the herds of the Cape Colony, Basutoland, Natal, and Zululand. As regards the subsequent use of the carcases of rinderpest animals, the consensus of opinion appears to deprecate as unsafe the practice of simply salting and drying rinderpest oxen hides, whilst it is also stated that the farmer cannot be trusted to convert fat into soap without risk of accidentally spreading the disease.

THE Kekulé Memorial Lecture, delivered before the Chemical Society on December 15 (see p. 180), by Prof. F. R. Japp, F.R.S., is published, with a portrait of Kekulé, in the February issue of the Society's *Journal*.

UNDER the title of "A Visit to Giessen; or, Thoughts on Liebig and Chemistry in Germany," Prof. Senier, of Queen's College, Galway, recently delivered a lecture. The lecture has now been published by Mr. Edward Ponsonby, Dublin, and it makes a very interesting pamphlet on Liebig and his work.

THE second part (for February 1898) of the monthly *Journal of Applied Microscopy*, published by the Bausch and Lomb Optical Company, Rochester, N.Y., contains a full account, with illustrations, of the very extensive and complete laboratories connected with Cornell University, viz. those for botany, microscopy, histology, embryology, bacteriology, and pathology.

THREE well-arranged catalogues of works on various branches of the mathematical and physical sciences have just been issued by Messrs. William Wesley and Son. The catalogues include works from the libraries of the Rev. A. Freeman, Dr. Albert Marth, and Dr. Hind. Rare and valuable memoirs and books are enumerated in the lists, and the scientific bibliophile who consults the catalogues will be repaid for his trouble.

THE results of meteorological observations made at Bangalore, Mysore, Hassan, and Chitaldrug, under the direction of Mr. J.

Cook, during 1896, has just been issued from the Mysore Government Central Press. In addition to meteorological statistics, the volume contains several plates, upon which the observations are represented graphically. The Report of the Meteorological Service of Canada for the year 1890 was also received a few days ago, together with a report on the observations made during 1895. Both of these reports are almost completely taken up with rows of figures referring to the meteorology of the Dominion.

THE Manchester Museum, Owens College, has just published, as a museum handbook, Parts ii. and iii. of a Catalogue of the Hadfield Collection of Shells from the Loyalty Islands. Since the first part of the catalogue was published, further consignments of shells have been received at the museum, the number of species recorded being thus increased from 630 to 860. The complete catalogue should be of considerable value to conchologists, as the collection of shells described in it is the largest and most important that has been received in this country from the Loyalty Islands.

THE first number of the thirty-second volume of the *American Naturalist* marks the issue of the magazine in a new and more attractive form. It is the purpose of the editors to make the periodical a means of encouraging the movement towards a closer union of the natural sciences. Superficial observations and poorly-grounded speculations are not to be published in its pages, but only articles and other contributions which have significance from various points of view. This ideal is a commendable one, and it remains for American naturalists to help the journal to attain it.

THE current number of the *Journal of the Royal Microscopical Society* (published bi-monthly on the third Wednesday in February, April, June, August, October and December) contains the tenth and concluding part of Mr. F. Chapman's very important account of the Foraminifera of the Gault of Folkstone. The greater part of the number is, as usual, occupied by the summary of recent researches in zoology, botany, and microscopy (structural and applied). The object aimed at is to give a brief abstract of every important paper (not purely systematic) in these departments of science, each section being under the care of a specialist sub-editor. The paragraphs on bacteriology are especially full and complete.

UNDER the title of the "Universal Lamp Time Chart," Mr. D. E. Benson, of Southport, is publishing an accurate and ingenious chart, constructed by Mr. G. Napier Clarke and himself, to show graphically the time at which cyclists must light up on any day of the month in any part of the British Isles. Separate charts are required for each month, and also for England and Wales, Scotland and Ireland; but though this will probably prevent the charts from being widely used, the idea of representing by a graphic construction the times for lighting and extinguishing lamps in different latitudes and longitudes in the British Isles is so good, that the authors deserve encouragement. Another publication in which those of our readers who ride cycles will be interested is "The Cyclist's Pocket Book" (Archibald Constable and Co.). The book contains a large amount of useful information and memoranda on the practice of cycling, and a few hints on the initial treatment of the commoner casualities to which cyclists are liable.

THE additions to the Zoological Society's Gardens during the past week include two Australian Sheldrakes (*Tadorna tadornoides*) from Australia, two Chinese Quails (*Coturnix chinensis*) from China, six Pintail (*Dafila acuta*), European, purchased; a Great Kangaroo (*Macropus giganteus*), an Australian Cassowary (*Casuarius australis*) from Australia, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MARCH 1898:—

March 1.	8h. 49m. Jupiter's Sat. IV. in conjunction S. of planet.
2.	10h. 10m. to 12h. 33m. Jupiter's Sat. III. in transit.
2.	10h. 51m. to 12h. 33m. Jupiter with only one visible satellite.
2.	13h. 40m. to 14h. 36m. B.A.C. 2238 (mag. 6·5) occulted by the moon.
4.	7h. 10m. to 8h. 29m. d^1 Cancri (mag. 5·9) occulted by the moon.
4.	8h. 44m. Minimum of β Persei (Algol).
9.	11h. 12m. to 11h. 51m. q Virginis (mag. 5·7) occulted by the moon.
9.	13h. 29m. to 15h. 14m. Jupiter with only one visible satellite.
9.	13h. 29m. to 15h. 53m. Jupiter's Sat. III. in transit.
9.	14h. 12m. Jupiter's Sat. IV. in conjunction N. of planet.
13.	14h. 38m, to 15h. 49m. α Scorpii (Antares, mag. 1·1) occulted by the moon.
15.	Illuminated portion of disc of Venus = 0·993.
	,, ,, ,, Mars = 0·968.
16.	16h. 46m. Jupiter's Sat. III. begins transit.
16.	16h. 46m. to 16h. 58m. Jupiter with only one visible satellite.
20.	Pons-Winnecke's comet due at perihelion.
21.	Minor axis of Saturn's outer ring 17″·63.
24.	10h. 27m. Minimum of β Persei (Algol).
25.	12h. Jupiter in opposition to the sun.
	Equatorial diameter = 44″·95.
	Polar ,, = 42″13.
26.	2h. Mercury in conjunction with Venus. Mercury 1° 14′ N.
26.	9h. 24m. Near approach of 23 Tauri (mag. 4·2) to the moon.
27.	7h. 16m. Minimum of β Persei (Algol).
30.	11h. 13m. to 12h. 14m. δ Geminorum (mag. 3·7) occulted by the moon.

ANOTHER LUNAR HOAX?—From very early times the moon has frequently been selected as a suitable object upon which to exercise the imagination or base an elaborate hoax. We may remember that Hubert gravely declared to King John "that five moons were seen to-night: four fixed: and the fifth did whirl about the other four, in wondrous motion." Such rough descriptions were good enough for the times in which they were uttered; but in days of more exact knowledge, the lunar fable must be prepared with greater elaboration and decked in a more scientific garb. When this century was young, a tale obtained some credence, because it was artistically disguised, concerning what astronomers could see on the moon's surface. It was reported that Sir David Brewster and Sir John Herschel had seen a lunar forest with trees resembling "the yews grown in English churchyards," and a "lunar ocean breaking in large white billows upon the strand, while the action of very high tides was quite manifest upon the face of the cliffs for more than a hundred miles." Now, at the end of the century, comes the latest lunar myth, and it necessarily must be surrounded with still greater nicety of detail, and clothed with an accurate terminology.

The author of the alleged discovery in this instance is Dr. Georg Waltemath, an astronomer of Hamburg. and his assertion is, that there is evidence of the existence of a second moon, circling about the earth, but with such low reflective power that it has usually escaped observation even when in opposition. The author has perceived the desirability of making this hypothetical moon do a useful work in celestial mechanics, by explaining that the difference between the observed and computed secular acceleration of the moon's mean motion arises from the action of the newly discovered body. Perhaps it might also, with a little art, be made to explain the motion of the perihelion of Mercury. A new comer who is able to remove some existing difficulties, is naturally more welcome than one who might introduce fresh disturbances. Therefore the mass must not be very great, and Dr. Waltemath assigns to the new body that he has discovered or deduced, a mass of 1/80 of that of the moon, and a diameter of 700 kilometres. The distance is put

at rather more than one million kilometres, 2·67 times the distance of the moon, and this gives the sidereal period 119·207434 days. The mean daily motion is given to the ninth decimal of a degree. We cannot say here what is sometimes said of a long row of decimals: the more figures one gives, the greater the chance for some of them being correct. The anomalistic period, too, is given with sufficient accuracy; so is the excentricity and the longitude of the node; everything, in fact, to enable an astronomer to compute the position of our new satellite. It is, of course, quite possible that Dr. Waltemath fully believes in the existence of this object. In that case we should say, he is the only person who does; for when we ask on what kind of observation does this very accurate orbit rest, we find that the author has employed that large collection either in which persons have believed that they have seen objects of doubted value transiting the sun, whether bright or dark. He seems to have trusted to those wild and reckless assertions that are made from time to time about "ruddy fireballs" or "night suns," or other vague descriptions, and on such loose and inaccurate data he has unfolded his strange and wondrous tale. This hypothetical satellite ought to have been seen transiting the sun on February 3, and, if we have correctly apprehended the author, may even yet be seen on July 30.

Occultation of Ceres.—The extremely rare phenomenon of the occultation of Ceres, on November 13 last, has been observed by M. Schorr, of Hamburg, and M. Harzer, of Kiel. A note in the *Bulletin de la Société Astronomique* for February states that only the reappearance was possible to be observed, and it was noted that the increase of light during one or two seconds was gradual, and not sudden as in the case of a star.

A Remarkable Object.—In Circular No. 46 from the Wolsingham Observatory, dated February 16, the Rev. T. E. Espin states that "a remarkable object hitherto unrecorded was discovered on January 16, and seen on three other nights. It is elliptical, one degree long, major axis 336°, and rather resembles some obscuring medium than a nebula, and is, I believe, unique." This object is situated on the northern border of Perseus adjoining the constellation of Auriga, its position being:

R.A. 4h. 26m. 0s., Decl. + 50° 44′ (1855).

Variables in Star Clusters.—Prof. Pickering, in Circular No. 24 from the Harvard College Observatory, states that "since the announcement made in Circular Nos. 2 and 18, of variables discovered in clusters, a further examination of the clusters ω Centauri, Messier 3, Messier 5, and N.G.C. 7078 has been made by Prof. Bailey. As a result, the numbers of known variables in these clusters have been increased by 62, 19, 22 and 24, respectively, making the total numbers 122, 132, 85 and 51, or 390 in all four clusters. Adding to these the 47 already announced in other clusters, makes the total number 437."

In the *Bulletin de la Société Astronomique*, M. A. Chévremont announces the discovery of a variable star upon the eastern margin of the globular cluster in Aquarius (M. 2). Whilst the stars of the cluster are of about the 15th magnitude, this new variable rises to mag. 12, at maximum, and is probably distinct from the cluster itself. It has a period of about thirty days, gradually decreasing from maximum to its minimum of mag. 14, in about fifteen days; the actual form of the light-curve is, however, only vaguely known, other observations being required to replace the hiatus of its ascent.

A Large Reflecting Telescope.—We learn from *Popular Science News* that another great telescope is approaching completion. In 1895 the Rev. John Peate commenced at Greenvill, Pennsylvania, the construction of a mammoth glass speculum for a reflecting telescope designed for the American University, Washington. After two years of arduous toil, Dr. Peate has given the great mirror its final touches—that is, in grinding and polishing—and it is now ready for silvering and for the further and important stage of mounting. This large disc of glass is more than 61 inches in diameter.

Parallaxes of Stars.—From observations made at the Cape Observatory, Dr. Gill concludes that the parallax of α Centauri certainly lies between the limits 0″·74 and 0″·75. This is equivalent to a distance of 275,000 times the radius of the earth's orbit. In the same journal (*Bulletin de la Société Astronomique*), we are informed that Dr. Gill comes to the conclusion that the parallax of Rigel is not greater than 0″·01, hence the distance of this star is certainly more than 20 million times the distance of the sun; it has, therefore, a "light journey" of 320 years.

The same author, in the *Monthly Notices* for January, gives, from his most recent researches, the parallax of α Gruis as 0″·015 ± 0″·007.

From measures of the mean parallaxes of the stars β, γ, δ, ϵ and ζ in Ursa Major, M. Hoffler has obtained the small value of 0″·0165 ± 0″·011. This number indicates that the system formed by these stars is separated from the earth by such a distance that it would take 200 years for the light to reach us. The distance of β and ζ is at least 4 million times greater than that which separates the earth from the sun. From the calculations made by this astronomer, ϵ Ursæ Majoris would be a star forty times brighter than Sirius, which, at the present distances of the stars, is considered the most brilliant in the sky.

FURTHER EXPLORATIONS IN AMERICAN MOUNDS.[1]

The greater part of this volume is occupied by Mr. Moore's account of his systematic exploration of the mounds on the Georgia coast, the Marquis de Nadaillac's short paper being added to draw attention to the parallelism between burial customs on both sides of the Atlantic. Mr. Moore's contribution is a worthy continuation of his previous work, and the classified results of his numerous excavations, accompanied by excellent diagrams and illustrative plates, form a welcome addition to the material already existing for purposes of comparative study. Americans have every reason to be satisfied with the manner in which the archæological investigation of their country is being carried out: such researches as these of Mr. Moore in Georgia, and those of Mr. Cushing among the Keys of Florida, reflect the greatest credit upon all who have contributed to bring them to a successful issue.

The general results of these explorations tend to confirm in a striking degree the conclusion that men in similar states of primitive culture hold similar views upon all the fundamental questions of life and death. Such resemblances are not merely confined to generalities; they may be observed in the most minute matters of detail. Thus not only does the puzzling coexistence of inhumation and incineration recur as frequently in American as in European barrows, but many peculiarities of interment, noticed by Canon Greenwell and others, are repeated in a very remarkable manner in these Georgian mounds. Amongst these peculiarities may be instanced the preference shown for the southern and eastern sides of mounds; the laying of unburned skeletons upon one side and in a contracted position; the presence of charcoal, and pigments like powdered hæmatite; the deposit of potsherds belonging to *different* broken vessels, and the protection of bodies by coverings of wood. But in spite of these numerous coincidences we are as far off as ever from discovering the psychological laws which regulated the disposal of the dead by primitive man. Mr. Moore found bodies in all kinds of positions. They were "flexed" upon one side, or extended at full length, sometimes in anatomical order, sometimes showing signs of having been transferred to the place of burial after the flesh had been removed by exposure to the air; bones of one or more skeletons were "bunched" in heaps; confused masses of bones belonging to many different persons occurred together, some being calcined, others not; there were "pockets" of cinerated remains; urn burials, both cremated and uncremated; and unburned bodies placed upon the sites of fires. In a word, the apparent confusion reaches an extreme degree, and almost the only regularities of association which Mr. Moore ventures to point out are the more frequent presence of implements and ornaments in the neighbourhood of confused masses of bones, their comparative scarcity with flexed burials, and their complete absence in the neighbourhood of extended skeletons, though these last were generally at the base of the mound, and were often placed in large artificial excavations. As to the general question of the simultaneous occurrence of inhumation and cremation, we must still, perhaps, fall back on the former hypothesis

[1] *Journal of the Academy of Natural Sciences of Philadelphia*, 2nd series, vol. xi. Part 1, Philadelphia, 1897. (1) "Certain Aboriginal Mounds of the Georgia Coast," by Clarence B. Moore. (2) "Inhumation and Incineration in Europe," by the Marquis de Nadaillac.

that mere juxtaposition with fire as a ceremonial purification may have been in some cases considered equally efficacious with the actual incineration of the bones. The Marquis de Nadaillac has brought together, with admirable clearness and brevity, a mass of negative evidence proving that no distinctive significance can be proved to attach to either of the two great methods of burial; indeed, in places like Hallstadt the confusion seems absolute.

The people who built these mounds must have been a race with very little stone, and almost without copper. Of this metal only a chisel and a few ornaments were found, among the latter being a ring still in its place upon a finger-joint. Their pottery was well represented, though lacking in diversity of type. It was ornamented by cord-marking, by incised and painted designs, and by complicated stamped patterns, some of which give the impression of having been derived from the grain of wooden ware, while others appear to owe their origin to life forms. All the types discovered are copiously illustrated in the plates at the end of the book, and in the woodcuts inserted in the text. The tobacco-pipes discovered differed from those found in Florida, and a mortuary earthenware with a ready-made perforation at the base was non-existent.

Of the other objects found associated with bodies, those made of shell were the most numerous. They included various implements, some possibly agricultural, drinking cups, ornamented gorgets, and large numbers of beads, the latter hardly ever showing traces of contact with fire. Objects of stone and chert were less numerous, but among them may be mentioned celts, hammers, lance and arrow heads, and discoidal stones smaller than those used in the game of *Chungke*, but probably employed in a game of a similar kind. The small pebbles, frequently found in little heaps near human remains, are supposed by Mr. Moore to be the contents of rattles, the turtle-shell covering of which has decayed away. Bone pins were of frequent occurrence; and animals' jaws ground away on the lower part, leaving a flat surface, were discovered in a few instances. Almost everything made of wood had entirely disappeared. What the art in wood of the mound-builders may have been we must conjecture from the discoveries made in the Florida Key dwellings, where the peat has been instrumental in arresting decomposition.

The south-eastern corner of the United States is an area of peculiar ethnographical interest, owing to its proximity to the greater Antilles and to South America: it is fortunate that its exploration has been entrusted to such competent hands, and that the results are published in so admirable a manner.

A JUBILEE VOLUME OF "WIEDEMANN'S ANNALEN."

ON December 11, 1847, Gustav Wiedemann was made Doctor of Philosophy of Berlin University with a thesis "De Novo quodam Corpore ex Urea producto." To celebrate the fiftieth anniversary of that event, the publishers of *Wiedemann's Annalen der Physik und Chemie* conceived the happy idea of printing a jubilee volume composed of special papers by the more regular contributors. The result is a collection of fifty-seven papers by a number of eminent men, including Kohlrausch, Nernst, Ostwald, Quincke, Drude, Warburg, E. Wiedemann, and others of equal distinction.

Four years ago, the golden jubilee of the *Annalen* was celebrated with a retrospect by Hermann von Helmholtz. These annals, with their lineal ancestors, *Poggendorff's and Gilbert's Annalen*, cover over a century of German physical science, and are a noble monument to German intellectual activity. No better jubilee gift could have been made to the veteran editor than this collection of choice fruits of his colleagues' labour. We subjoin some extracts which will indicate the nature and value of the work offered, regretting that space does not permit of more.

Reversal of the valve action in discharge tubes, by E. Hagenbach. When the gas in a discharge tube is only slightly exhausted, a conduction current is established at a certain pressure. At higher exhaustions a radiation of electricity sets in, chiefly from the kathode. This radiation takes place more easily from a point kathode than from a surface at the lower pressures, while at higher pressures the reverse is the case.—Torsion and magnetism, by P. Drude. The explanation of the connection between torsion and magnetism must be based upon the different amounts of internal friction encountered in longitudinal and transverse deformations respectively, giving rise to a peculiar orientation of the magnetic molecules.—The law of Wiedemann and Franz, by F. A. Schulze. This law maintains that the ratio between the thermal and electric conductivities is approximately the same for all metals. The author tested this for iron and steel rods, and found them to exceed the ratio, but not by so much as has been alleged by previous investigators.—Theory of galvanic polarisation, by A. Oberbeck. The determination of the galvanic polarisation in the original circuit is not an impossibility, as has been alleged. It may be closely approached along several lines. The capacity of a cell is a function of the polarisation. It becomes infinite when a certain superior limiting value of the polarising force is reached which produces the maximum polarisation. After that the polarised cell behaves like a constant cell opposed to the main current.—Magnetic after-effect, by I. Klemenčič. Instead of disappearing in strong fields, the magnetic after-effect, or the "viscous magnetic hysteresis," goes on increasing, but its percentage in the total magnetisation becomes less.—An acoustic thermometer for high and low temperatures, by G. Quincke. This thermometer is based upon the interference of a direct and reflected sound-wave of known length, produced by a standard tuning-fork. The wave travels along a tube surrounded by the temperature to be measured. A hearing tube is moved to and fro within the interference tube until a node is reached, indicated by the silence of the hearing tube. The displacement of the latter is read on a divided scale, and immediately indicates the temperature required.—Excitation of stationary waves by electric spark discharges, by F. Melde. An embroiderer's "gold thread" is made to vibrate between the knobs of a battery of jars, somewhat on the principle of the electrostatic cells.—Magnetic susceptibility and atomic magnetism, by G. Jäger and S. Meyer. The authors have found an interesting new relation between the paramagnetic metals. They investigated the magnetic susceptibilities of the chlorides, sulphates, and nitrates of iron, nickel, cobalt, and manganese in aqueous solution at various temperatures. The metal was found to be the decisive element, the acid being without influence. The magnetic susceptibilities per gramme-atom of nickel, cobalt, iron, and manganese were as 2 : 4 : 5 : 6. The gap between 2 and 4 is probably filled up by chromium.—Stratified discharge in the open air, by Max Toepler. The author has succeeded in obtaining a distinctly stratified discharge at atmospheric pressures, which recalls the stratified anode light, by interposing in the path of the spark a semi-conducting plate of dry slate, granite, syenite, or basalt, and ballasting the discharge with a heavy water resistance. Between the bright surface on the kathode and the first stratum a sharp black space is seen, usually very narrow, which is analogous to the black kathode space, and tends to show that there is no fundamental difference between ordinary and vacuum discharges.—Magnetic images, by H. Jaeger. The method of magnetic images may be extended to the case of a constant current traversing a conductor in the neighbourhood of an iron plate. The field created by the current and by the iron plate is the same as if another conductor were placed at the geometrical image of the first conductor in the iron plate, and the latter were removed.—Heating effect of Röntgen rays, by E. Dorn. The author measured the heating effect produced on sheets of platinum or palladium contained in a glass vessel with an aluminium window. The vessel communicated with a Toepler pressure gauge, and the heat was measured by the expansion of the gas. The expansion obtained is much larger than would be accounted for by a dissociation of the gas.—Electroscopic detection of electric waves, by A. Toepler. Describes a modified electroscopic arrangement of great sensitiveness. Two upright metallic cylinders stand in a box with walls of glass and ebonite. One of the rods is connected with a rectilinear resonator, the other is put to earth. Any wave incident upon the resonator which produces sparks, sets in violent motion a fine aluminium wire suspended between the two cylinders, which conveys the discharge from one to the other. The aluminium wire is attached to a steel needle, which is just held suspended by its point by a permanent magnet.—Counter electromotive force of aluminium, by V. von Lang. It is well known that in an aluminium-carbon electrolytic cell a current with a voltage under 22 will only pass in the direction carbon-aluminium, and this has been utilised for the electro-chemical rectification of an alternate current. Similarly, in an arc with two aluminium electrodes, a counter E.M.F. of some 19 volts is

developed. An arc with one electrode of aluminium and one of carbon allows the current to pass with greater ease from aluminium to carbon, which is just the reverse of what happens in the cell.—Influence of magnetism on the strength of electric vacuum discharges, by A. Paalzow and F. Neesen. The discharge was produced by a constant high-potential battery. When the lines of force acted across the path of the current, the latter was always enfeebled, and sometimes broken. When they acted along the path, the magnetic field acted like an increase of pressure of the gas, delaying both the setting-in of the discharge and its extinction in the course of exhaustion.—Relation between the positive light and the dark kathode space, by E. Wiedemann. When a positive wire anode is brought into the dark kathode space, the resistance of the intervening gas is not lessened but increased. The positive light bends back until it merges in the negative glow. The same thing happens when the anode is surrounded by a narrow tube. In every case, the discharge traverses the positive strata and the negative glow in succession before it enters the dark space —Simple demonstration of the Zeemann effect, by W. König. An emission flame which can be placed in a strong magnetic field is viewed through an absorption flame and a dichroiscope or a doubly-refracting prism, which gives two images of the emission flame side by side. On making the field one of the images brightens up, owing to the length of its light waves being changed, and therefore no longer absorbed by the absorption flame.—Magnetic and electric wind, by O. Lehmann. Describes some curious cases of the modification of the path of an electric discharge by a magnetic field. An arc between a ring of carbon and a concentric rod of carbon may be made to spin round rapidly, and a comet-like appendage may be made to revolve round the kathode in an "electric egg."

MAN IN RELATION TO THE GLACIAL PERIOD.[1]

As there appears even now to be a doubt in the minds of some as to whether man reached Britain before, during, or after the time known to geologists as the "Glacial period," it might be well on the present occasion to re-examine some of the evidence which has been brought forward to prove the presence of pre-Glacial man, especially from those areas in Britain which are now admitted to contain Glacial deposits, or to have been overspread by ice and snow in the Glacial period.

The most important evidence yet obtained, is that which has been furnished by the ossiferous caverns in the glaciated areas; but the occurrence in the same areas of the remains of extinct mammalia, which are now admitted to have been contemporary with the Cave Man, buried under great thicknesses of Glacial deposits, must also have an important bearing on the question.

All the evidence tends to show that the so-called Tertiary and Quaternary periods merged gradually into each other, and were not separated by any great break in Britain. The higher mountains, before the close of the Tertiary period, must have been covered in part by ice and snow, and the so-called Glacial period can only have a chronological importance as indicating the increased intensity and climax of that cold condition gradually ushered in at the earlier time. For the same reason there is no marked and definite line separating the fauna of the Pliocene from that of the Pleistocene, for we find remains of the animals of the warmer period closely associated with those of the colder in the same deposits and under conditions which show clearly that they lived in those areas at the same time.

North Wales and the North-west of England.

It is generally admitted that during the latter part of the Pliocene period the mountains of North Wales stood at a considerably higher elevation than they do at present; therefore it is but natural to suppose that during that time the streams which flowed from them gradually deepened, widened, and also possibly carved out some of the pre-Glacial valleys. The Carboniferous limestone along the flanks of the mountains, which had at an earlier time been much broken and crushed by earth-movements, now suffered from the additional effects of subaerial action, and wide fissures and caverns were gradually formed in it. In time some of these, as the streams found outlets at lower levels, would be left comparatively dry, and would then be suitable for habitation by man and beast.

In nearly all those caverns where remains of the extinct animals and the implements of contemporary man have been found, there is some amount of sediment underlying the remains. This must have been left there by the streams or floods which also deposited the materal which filled up the narrow descending fissures, thereby making a fairly level floor to the caverns before occupation. This material in every case, unless where there is evidence of its having been subsequently disturbed, consists entirely of such local materials as would be brought down by the streams from the immediately adjoining higher ground. When the higher caverns were first occupied by hyænas it is probable that there was comparatively little ice or snow on the mountains, and many of the animals which lived in the valleys and on the plains extending from them were southern types. Gradually, however, as the cold increased, northern forms appeared on the scene, and a commingling of the two groups took place.

The geographical features in the west and north-west in later Pliocene times may be briefly summarised as presenting high mountainous areas in Wales, Cumberland. the South of Scotland, and in parts of Ireland bordering the Irish Sea and St. George's Channel, with extensive plains traversed by great rivers in the areas now submerged, between the west coast of England and Wales, and Ireland. The conditions here were then in every way suitable to form feeding-grounds for herds of the great mammalia, and indeed such as could never have been repeated afterwards in these areas either in late Glacial or in post-Glacial times.

Animals from the south-east could reach these north-western plains across Cheshire and the lowlands in the centre of England, and others from the south by the plains on the west coast of Wales. In this way northern and southern animals would in a sense freely commingle and be afterwards driven to more southern areas together as the cold increased, and the conditions became more and more unsuitable to them. At first, in the mountains bordering these plains, when only their higher parts were covered with ice and snow, glaciers would occur only in the higher valleys; but as the cold increased they would become confluent with those from adjoining areas, and in time reach the plains and there coalesce to form, perhaps, as has been suggested, one vast sheet reaching across from England to Ireland. Most of the animals, ere the last stage had been reached, would, of course, have disappeared from those parts towards more suitable southern areas.

That the foregoing is, in brief, the history of the incoming of the Glacial period in the north-west is evident from the deposits which have been found in and about the caverns, and in sections at various points on the hills, in the valleys, and around the coast of North Wales.

Wherever the earlier materials have been preserved, especially at high levels, they are seen to consist entirely of local materials, *i.e.* such as would be derived from the immediate neighbourhood, or carried down by streams or ice from the adjoining higher ground.

Over this, and partly mixed up with it in the areas not reached by the northern ice, there is an admixture of materials from other Welsh districts and in the valleys opening out to the north, and along the coast there is the further admixture of erratics from northern areas. It is an interesting fact that the boundary-line in the Vale of Clwyd reached by the northern erratics is very little more inland than the area in which the caverns we have explored occur.

Of the history of the subsequent changes I need say but little; but it seems to me that there is fairly good evidence to show that a considerable subsidence did take place towards the close of the Glacial period, and that this was afterwards followed by a certain amount of upheaval in the same areas.

The presence of such thick deposits of drift, below the level of the sea, at the entrance to the Vale of Clwyd, with bones of the early Pleistocene mammalia at the very base, is a fairly sure test of a stage of subsidence, and it is also difficult to account for the finding of numerous foraminifera in clays at a height of about 200 feet above present sea-level around the coast unless alternating movements of subsidence and upheaval took place. The marine sand with broken shells at high levels, formerly looked upon as sure evidence of subsidence to that depth must not be relied upon too confidently, as in no case has it been clearly shown

[1] "Evidences of the Antiquity of Man furnished by Ossiferous Caverns in Glaciated Districts in Britain." Abstract of Presidential Address to the Geological Society, delivered at the annual meeting, February 18, by Dr. H. Hicks, F.R.S.

that the organisms lived in the positions where the shells are now found. In some cases there are also fairly clear indications that the deposits have been transported to fairly high levels by ice which had passed over and scraped up materials from the sea-bottom.

It seems safer, at present, from the evidence which has been brought forward of late years by so many competent observers, to assume that towards the close of the Glacial period the earth-movements produced changes only of a few hundred feet rather than the greater depression and upheaval suggested by the earlier geologists.

Early Pleistocene Conditions on the East Side of England.

On the east side of England, as on the west, there were at this time great plains, extending out from the valleys, and much of the area now covered by the North Sea must have been dry land where northern and southern animals commingled. That this was the case is shown by the finding of their remains in close association in the hyæna-den at Kirkdale and in other caverns in Yorkshire. Prof. Phillips many years ago came to the conclusion that the Kirkdale Cave was occupied in the "pre-Glacial condition of the land which is now Yorkshire," and he also maintained that the lowest Hessle Gravels which rest upon the chalk, and which contain mammoth and other remains, and are covered by Boulder-clay, are pre-Glacial in age.

Mr. G. W. Lamplugh's careful researches seem to show clearly that the Sewerby Gravels, which have yielded so many Pleistocene remains, are at the base of the glacial series in that area. He says of the fauna at the base of the drift at Sewerby:—"It is essentially the fauna of the Kirkdale Cave."[1] In his conclusions, given in the same paper, when referring to the physical conditions prevailing in the area during the formation of the drift-deposits, he says:—"At a period not long anterior to that of the glaciation of the coast, Flamborough Head was in existence as a bold promontory jutting out into a sea whose level was slightly above that of to-day. Most of the mammals characteristic of the Glacial period were already living, and tenanted the interior in large numbers. The climate was moist and not very severe, the prevalent winds, as shown by the sand-dunes of Sewerby, being from the west or south-west. After the land had remained for a long time stationary, a slow elevatory movement set in, and the climate became much colder; so that the Chalk-surface was disintegrated by frost and eroded by sudden floods, which spread thick beds of muddy detritus over much of the low or slightly sloping ground in the vicinity. Meanwhile the bed of the North Sea was being rapidly filled with ice through the great extension of the Scandinavian glaciers, till at length the Scotch and Scandinavian ice coalesced, and what remained of the North Sea was well-nigh ice-locked."

Although some southern forms whose remains have been discovered in the forest-bed on the Norfolk coast do not appear to have reached much further north than that area, this does not, in my opinion, make it in any way certain that even these were not, in part at least, contemporaneous with the so-called mixed early Pleistocene fauna of the more northern districts. It is also an important fact that many of the most characteristic animals whose remains have been discovered in the caverns in North Wales and Yorkshire are now always included in the fauna of the forest-bed. The position of the forest-bed of Norfolk under high cliffs of Boulder-clay is also very similar to that of the lower deposits near the entrance to the Vale of Clwyd, containing Pleistocene remains and trunks of trees in like manner covered over by a great thickness of Glacial drift. It may also be compared with the forest-bed in Holyhead Harbour, buried under "stiff blue clay," in which two perfect heads of the mammoth were found when the excavations for the railway were made in 1849. The tusks and molars were buried two feet deep, in a bed of peat three feet thick, with stumps and roots of trees.[2]

It may be well to mention that the following mammals, whose remains have been found in caverns in North Wales, Derbyshire, and Yorkshire are now generally given as forming a part of the fauna of the Norfolk forest-bed, and that several of them, such as the glutton, musk sheep, and mammoth must be considered typically northern animals. The list is taken from those published by Prof. Boyd Dawkins or Mr. E. T. Newton, and there are animals which may be classed as characteristic of arctic, temperate, and hot climates. Animals whose remains have been found in caverns in association with human implements, and which are stated also to occur in the Norfolk forest-bed, viz. *Elephas antiquus*, *E. primigenius*, *Hippopotamus amphibius*, *Equus caballus*, *Sus scrofa*, *Bison*, *Ovibus moschatus*, *Cervus elaphus*, *Cervus capreolus*, *Megaceros*, *Machairodus*, *Canis lupus*, *C. vulpes*, *Hyæna crocuta*, *Ursus spelæus*, *Gulo luscus*, *Lutra vulgaris*, *Arvicola amphibius*.

When the cold increased, the animals on the East coast, as on the West side, were driven further and further south, and those least able to bear the increased severity of the climate were the first to migrate from the various areas. The southern forms may consequently be looked upon, for the areas in which they have been found, as the oldest fauna; but it is reasonable to suppose that they were contemporary with the more northern forms, which at that time lived in other districts where the conditions were more suitable to them. When the northern forms reached the South of England, the conditions in and around the mountainous districts were such that few animals could remain there, as most of the valleys and plains had become buried under ice and snow, and they would have to seek feeding-grounds outside these areas. It is to this period that we must assign the remains of the mammoth and rhinoceros which are so abundantly found on the old land-surfaces on the north of the Thames, usually hidden under great thicknesses of drift, as in Endsleigh Street, and in other places in Middlesex. Here, and in some areas further south, they could have lived during most of the Glacial period until at last driven away, when the valleys and plains became covered with vast sheets of water, due in part probably to subsidence, but largely owing to the gradual melting of the ice and snow further north. Whether the mammoth and rhinoceros continued to live much longer in some parts of the South and South-west of England there is very little evidence at present to show. The supposition, however, held by some that they returned to the glaciated areas after the Glacial period had passed away does not seem to me in any way probable, for hitherto their remains have only been found either under or in the drift, and not above it, excepting when they have been washed out from the earlier deposits.

Summary.

The evidence which has been obtained from ossiferous caverns at high elevations in the glaciated areas shows conclusively that the remains of the extinct mammalia found in them must have been introduced before any of the Glacial deposits now in or upon them could have been laid down, therefore either before or so early in the Glacial period that there could not have been at the time any considerable amount of snow on the neighbouring mountains, or glaciers even in the higher valleys.

From caverns in glaciated areas in North and South Wales, where palæolithic implements have been found in association with remains of the extinct mammalia, facts have been obtained which make it certain that the implements were those of man living at the same period as the extinct animals in those areas, and therefore of pre-Glacial age. It has also been shown that as the cold increased the higher valleys became filled with glaciers, and the caverns became uninhabitable. That afterwards, as the snow-line and glaciers descended lower and lower, some of the caverns were subject to inundations, which not only disturbed and rearranged the deposits previously in them, but wholly or partially filled them up with local materials. That in the Vale of Clwyd, North Wales, the local glaciers gradually coalesced with those from the western and northern areas, and a mixed material was distributed over the district to a height of over 600 feet, burying the ossiferous caverns beneath it. During this time also water re-entered some of the caverns, redisturbing in part the earlier contents and depositing some of the mixed drift over that previously in the caverns.

While these caverns were occupied as dens by the hyænas, northern and southern animals commingled in the valleys and on the great plains reaching out from them to the area now covered by the Irish Sea.

From numerous examinations made of undisturbed Glacial deposits in Wales, the North of England, and Scotland, it has also been proved very clearly that the extinct mammalia, whose remains are found in association with the implements of Palæolithic Man in caverns, must have lived there before those deposits had been laid down, as their remains always occur at the base or in the lower parts of the drift, and never above it. Further, there is not a particle of evidence to show that the extinct mammalia ever revisited those areas after the close of the Glacial period.

[1] *Quart Journ. Geol. Soc.*, vol. xlvii. (1891).
[2] "Principles of Geology," Lyell, vol. i. (1867) p. 545.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. W. D. Niven, F.R.S., has been appointed an Elector to the Plumian Professorship of Astronomy, and Sir W. H. Broadbent an Elector to the Downing Professorship of Medicine.

Mr. J. Graham Kerr, of Christ's College, well known for his adventurous journeys as a naturalist in South America, has been elected a Fellow of Christ's College.

PROF. G. B. HOWES, F.R.S., is to receive the honorary degree of LL.D. from the University of St. Andrews.

WHEN a shorthand writer, only familiar with the phonographic signs of the vocabulary of every-day life, endeavours to take notes of a science lecture, he soon finds his deficiencies. To exercise pupils in the art of making shorthand notes during lectures, Mr. Percy E. Kingsford, of Dover College, has inaugurated a course of special science lectures (with experiments and other illustrations) as nearly as possible of the character of those which his students will receive when they pass to the science or technical college, or medical school. The practice thus afforded the students will be very valuable. Science lecturers who have suffered at the hands of newspaper reporters, and have had ideas fathered upon them which they would be the first to repudiate, will join with us in wishing that all phonographers would undergo a similar course of training in reporting scientific lectures. It is very difficult to obtain an accurate verbatim report of the speeches made at any meeting where scientific subjects are discussed.

AN open competitive examination for the entry of engineer students in Her Majesty's Navy, and for the entry of students in Naval Construction, will shortly be held. The opportunities offered by this branch of the naval service are not so widely known as they ought to be. Candidates for the studentships must not be less than fourteen, nor more than seventeen years of age. A competitive examination is held every year in April, the subjects being arithmetic, writing from dictation, composition, grammar, French (or German or Italian), Latin, elementary physics and chemistry, geography (including physical geography), algebra (including quadratic equations), Euclid's Elements (Books I.-IV., VI., and definitions of V.), and freehand drawing. Successful candidates go to the admirable Engineering College—the Royal Naval Engineering College—at Keyham, Devonport, and there receive, under Prof. A. M. Worthington, F.R.S., a thorough course of instruction in the various branches of engineering science, while at the same time they receive practical training in the Dockyard. The best of means is thus afforded the students of acquiring the groundwork of the theoretical and practical knowledge required of a modern naval engineer. During the five years which the students have to serve at Keyham, the parents or guardians are required to pay the sum of 40*l.* per annum; but for this the students receive an excellent education, as well as board and lodging and medical attendance. At present, a large number of the students come from naval ports, such as Portsmouth and Devonport; but if the studentships were more widely known, doubtless many places which are now but rarely represented would send in candidates for them.

THE jubilee of Queen's College, London, will be celebrated during the first week in May. The College was founded in 1848, and incorporated by Royal Charter in 1853. It was the pioneer of the movement for the development of educational facilities for women, and in the list of past and present professors and lecturers the names of a number of distinguished men of science occur. Among the names of Fellows of the Royal Society who have served the College, but have now passed away, we notice D. T. Ansted, Edward Forbes, W. B. Carpenter, and W. A. Miller; while among the present Fellows whose names figure in the list are Prof. H. G. Seeley and Prof. J. M. Thomson. The College curriculum is divided into three parts for students of different ages, and in each of the departments the development of mental powers without undue strain is the object of the instruction, preparation for public examinations being given but secondary consideration. A college which in these days does not shape its curriculum according to the syllabuses of examining bodies deserves encouragement; and Queen's College should, therefore, not lack responses to the appeal which the Council has issued for means to enlarge and generally improve the premises, so as to meet the increased requirements of modern education. Among the additions will be a large lecture-room for science lectures. The estimated cost of the whole work will exceed 7000*l.*, of which sum more than 3000*l.* have still to be raised. The College has no endowment for such purposes, and it appeals for help to all who recognise the important share it has taken in the development of women's education. The object is a worthy one, and it is to be hoped that the greater portion of the sum required will be raised before the jubilee celebration in May. The Lady Resident would be glad to receive the names and addresses of old students, in order to send invitations for the forthcoming event.

A COPY of the general report on public instruction in the North-western Provinces of Oudh, for the year 1896-97, has been received. The institution of a Faculty of Science in the University of Allahabad is referred to, and mention is made of various other efforts to encourage the study of science. What appears to be more needed than anything else is a more liberal supply of apparatus for experimental purposes. It is discreditable that Prof. Murray, who has charge of the physical science classes in one of the Government colleges, should have to report: "We have about nine metre scales in the laboratory; no two are exactly alike, and which (if any) is correct it is impossible to say. Similarly the variations in our various measures of resistance one with another are in some cases as much as 30 per cent. of the whole." But notwithstanding this unsatisfactory state of things, the report shows that means are being taken to strengthen the colleges on the science sides, both by providing additional apparatus and by increasing the accommodation. The subjoined extract from the report shows that the development is taking place on the right lines:—"Steps have been and are being taken to make school education less bookish, and more practical. An English writer, after thirty years of teaching, has recently urged that geography should be taught mainly by means of map drawing; that text-books should be used chiefly as books of reference; that lessons in arithmetic and geometry should include practical work in measurement; that in teaching modern languages the written or spoken language should be made the basis, and instruction in grammar founded upon it; that mastery of English does not come by grammar and analysis, but by observation and practice; and that true science consists in a scientific habit of mind, and not in a knowledge of scientific facts. These views appear to me to be fully applicable to India, and as a matter of fact similar aims have been kept in mind latterly in these provinces, particularly as regards geography, arithmetic, geometry and science. The idea of using text-books in most subjects as books of reference is, however, so contrary to the notions of masters and boys that it will be long before the new revelation is generally received."

SCIENTIFIC SERIALS.

American Journal of Science, February.—The 27-day auroral period and the moon, by H. H. Clayton. Auroras were observed in 1895 on January 19, February 15, March 14, and April 10, with no intermediate cases. The probability of an accidental distribution in this manner is only 1 in 19,683. This period is probably due to the varying position of the moon north and south of the equator. When the moon's period is counted from its greatest northern position, there is a maximum on the 14th day, which coincides with the moon's greatest southern declination. There are minima on the 6th and 20th days, and a secondary maximum on the first day. The moon is an electrified body, charged negatively like the earth, and the potential gradient at the earth's surface depends upon the moon's position in the heavens.—Some products found in the hearth of an old furnace upon the dismantling of the Trethellan tinworks, Truro, Cornwall, by W. P. Headden. The ores smelted in this furnace for about 100 years were the usual Cornish tin-ores carrying some arsenopyrite, which is cobaltiferous, and accounts for the cobalt in the samples. The chief products described are stannous sulphide, SnS, with some iron, a new iron arsenide, FeAs, an arsenide of tin, Sn_6As, and stannic oxide, or an artificial "wood tin." The latter was an irregular mass weighing about one and a half pounds. There was a central portion of metallic tin running lengthwise through the mass. It was probably formed by slow oxidation of a block of tin, but whether that was due to simple air and moisture or to other hot gases cannot now be determined.—Kant as a natural philosopher, by G. F. Becker.

Kant's fame as a metaphysician has completely overshadowed his reputation as a physicist; but all his earlier papers were on physical subjects, such as the theory of winds, the earth's rotation period, the rings of Saturn, and, best-known, the nebular hypothesis of the universe. His great object in life was to discourage visionary speculation and to reduce all subjects to the confines of reason. Where Newton had in some cases to postulate the direct intervention of the Creator, Kant based his explanation upon known physical laws. If he had known the laws of thermodynamics, his nebular hypothesis, which only fell short in that respect, would have completely anticipated Laplace.—The islands and coral reefs of the Fiji group, by A. Agassiz. This is an extract from a letter dated Suva, Fiji Islands, December 15, 1897, describing a cruise in the Australasian twin-screw steamer *Yaralla*. The writer says: The great variety of causes which have been active in shaping the present physiognomy of the reefs and atolls of Fiji shows the impossibility of assigning any one factor, like subsidence for instance, as is done by Dana and Darwin, as the single cause for the formation of the many different kinds of atolls and barrier reefs to be found in the Fiji group. The formation of the great barrier reef of the southern shores of Viti Levu is due to causes very similar to those which have given to the northern coast of Cuba between Nuevitas and Matanzas its present physiognomy.

Symons's Monthly Meteorological Magazine, February.—Meteorological observations at Camden Square, London, N.W. There are few records day and night for forty years without a break, and no station with suitable exposure in London which has been at work so long. We are glad to see that Mr. Symons intends to give a series of tables showing the results of his observations for each month, and the present number, being the first of a new volume, contains those for January 1858-97.—Warmth, dryness, and high barometer in January 1898. A number of notes are quoted upon the above subjects; the table above referred to shows that, for London, the features of 1898 are: barometer almost unprecedently high; mean dry bulb temperature, 0·05° above 1884, and therefore the highest on record; minimum in air and on grass, 0·6° and 0·5°, respectively, above the highest previous records, which were in 1875 and 1884; rain, only about a third of the average, but more than twice that of 1880.—In the Conway Valley geraniums were found in blossom out of doors.

SOCIETIES AND ACADEMIES.

London.

Royal Society, February 3.—"Comparison of Oxygen with the extra Lines in the Spectra of the Helium Stars, β Crucis, &c.; also Summary of the Spectra of Southern Stars to the 3½ Magnitude and their Distribution." By Frank McClean, F.R.S.

In a previous paper read before the Society on April 8, 1897, it was suggested that the special lines present in spectra of the first division of helium stars (Type I., Division I*a*) might possibly be due to oxygen.

The indications in the spectra of the northern stars that these extra lines are due to oxygen are slight, as the lines at best are indistinct. Among the southern stars, however, there are several in the spectra of which these lines are better defined, and there is one, viz. β Crucis, in which they are very fairly defined.

Upon the plate which accompanies the paper a series of photographs of stellar spectra are reproduced. The lines are drawn out by themselves below the spectrum of β Crucis. They are then compared directly by juxtaposition with a drawing of the spectrum of oxygen. The close similarity of the whole grouping of the two spectra as they appear on the plate admits of little doubt that the extra lines actually constitute the spectrum of oxygen.

The spectrum of γ Argus is given on the plate in order to identify it as a helium star. It contains two crucial lines of helium. The Wolf-Rayet stars, of which it is the principal example, are thus classified as helium stars.

A summary of the spectra of 116 stars to the 3½ magnitude in the Southern Hemisphere is given. They were photographed between May and October last with an object-glass prism, mounted in front of the Cape astrographic telescope. The photographic spectra are classified on the same system as in the previous paper. The table of distribution for the whole sphere by areas and classes is given.

There are in all 89 helium stars (Division I.), distributed 71 in the galactic zones and 18 in the galactic polar areas, the areas being equal.

The 81 stars in Division II., the Sirian stars, and Division III., the Procyon stars (which along with Division I. constitute Secchi's Type I.) are rather irregularly distributed throughout the sphere. To the extent of the observations there is no condensation of stars of Divisions II. and III. in the galactic zones as there is in the case of stars of Division I.

The 106 stars in Divisions IV. and V. (II. and III. of Secchi's types) are fairly evenly distributed throughout the sphere.

The general distribution of the types of spectra throughout the sphere to the extent of the observations bears out generally the conclusion that stars with spectra of the more advanced types, in order of development, are evenly distributed in space. Also that stars with spectra more recent in order of development are mostly congregated in the galactic zones. The helium stars of Division I. are predominant in the Southern Hemisphere, being congregated in the lower or southerly halves of the galactic zones. They include 48 stars out of a total of 94 stars in those areas. They are also more closely congregated in the vicinity of the galaxy than is the case in the northerly halves of the galactic zones. In the contiguous constellations of Musca, Crux, Centaurus, Lupus, and Scorpio there are 27 helium stars out of a total of 36 stars included in the tables.

February 17.—"Upon the Structure and Development of the Enamel of Elasmobranch Fishes." By Charles S. Tomes, M.A., F.R.S.

The nature of the hard polished outer layer of the teeth of this group of fishes has been from time to time a subject of discussion, some authors holding that it is enamel, whilst others deny its claim to be so styled.

The general conclusion arrived at by the author is that, just as the whole teeth of the Elasmobranchs present the simplest known form of tooth development, so do they also present the first introduction of enamel as a separate tissue.

In its first introduction it was a joint product, made under circumstances which almost precluded any slow and gradual formation of an outer layer upon the teeth; but in the further specialisation of teeth in reptiles and mammals the tooth germs sink more deeply into the submucous tissue, and are protected for a much longer time.

The enamel organs become more specialised, and finally take upon themselves the entire work of enamel building, manufacturing both the organic matrix and furnishing it with lime salts, as unquestionably happens in mammals.

And if these conclusions be correct, it would be quite justifiable to call it enamel, even though the dentine papilla has had a share in its production.

Geological Society, February 2.—Dr. Henry Hicks, F.R.S., President, in the chair.—The President announced that Dr. Charles Barrois, Secretary of the Organising Committee of the VIIIth International Geological Congress, which will be held in Paris in 1900, would shortly come to London to invite the Geological Society to the Congress, and to consult the Fellows with regard to the proposed excursions and the subjects of discussion.—"Contributions to the Glacial Geology of Spitsbergen," by E. J. Garwood and Dr. J. W. Gregory. The extent of glaciation of Spitsbergen has been exaggerated, for there is no immense ice-plateau, but normal glaciers with some inland sheets and Piedmont glaciers. These differ from Alpine glaciers, as they are not always formed from snow-fields at the head, and though some of the glaciers (as the Baldhead Glacier) have tapering snouts in front, most have vertical cliffs. Chamberlin's explanation that the latter are due to the low angle of the sun is insufficient, and they seem to be caused by the advance of the ice by a rapid forward movement of its upper layers. The ice of these upper layers falls off and forms talus in front, over which the glacier advances, carrying detritus uphill with it, and producing a series of thrusts. The Booming Glacier illustrates cases of erratics carried in different directions by the same mass of ice. The deposits of the Spitsbergen glaciers are of four types: (1) moraines of Swiss type; (2) those formed mainly of intraglacial material; (3) those formed of re-deposited beach-material; (4) deposits of glacial rivers, and re-assorted drifts. The materials of the second are subangular and rounded; scratched and polished pebbles and

boulders are abundant, and the fine-grained matrix, which is frequently argillaceous, is often well-laminated and false-bedded. Some of these drifts are stratified, others unstratified, and contorted drifts occur. This type of moraine is remarkably like some British boulder clay. The third class is sometimes formed by land-ice, at other times beneath the sea; the latter shows stratification. The superglacial and intraglacial streams, so far as seen, were usually clear of drift. Under the fourth head an esker in a tributary of the Sassendal is described. The direct geological action of the marine ice is of four kinds: transport of material, contortion of shore-deposits, formation of small ridges of boulder-terraces above sea-level, and striation, rounding, and furrowing of rocks along the sea-shore. Traces of former glaciation are described in the case of the Hecla Hook beds, and of certain beds of late Mesozoic or early Cainozoic age in Bunting Bluff. Under the head of general conclusions the authors state that they have discovered no certain test to distinguish between the action of land-ice and marine ice; that there is no evidence to prove that land-ice can advance far across the sea; and that there is evidence, which they regard as conclusive, of the uplift of materials by land-ice. They note that the mechanical processes connected with the advance of the glaciers are of three kinds. All the material seen transported by the glaciers was superglacial or intraglacial, and not subglacial. Some striation of intraglacial material is caused by differential movement of different layers of ice. The advance and retreat of the Spitsbergen glaciers is very irregular, and apparently due to local changes. The observations of the authors support the views of those who ascribe a limited erosive power to glaciers. Lastly, the theory that glacial periods occurred as a consequence of epeirogenic uplifts receives no support from Spitsbergen.—An interesting discussion followed, in which Sir Martin Conway, Prof. Bonney, the Rev. Edwin Hill, and Mr. Marr took part. Mr. P. F. Kendall said that the paper would mark a distinct epoch in British glacial geology. Hitherto, one body of geologists had attributed the drift-deposits of Britain to the agency of land-ice, while another had invoked the agency of the sea. The latter had argued that glaciers cannot move uphill, that they cannot transport materials from lower to higher levels, that glaciers cannot gather up materials over which they are moving, and that, even if they could pick up shells they would grind them to powder—"On a Quartz-rock in the Carboniferous Limestone of Derbyshire," by H. H. Arnold-Bemrose. The paper describes the occurrence in the field and the microscopic structure of a rock consisting essentially of quartz, which is found in the mountain limestone in several localities. It occurs in irregularly-shaped bosses and veins, and shows no signs of stratification. The author considers that the quartz-rock is not a gritty limestone, altered by the growth of crystalline quartz around the detrital grains, but that it is a limestone replaced by quartz.

Mathematical Society, February 10.—Prof. Elliott, F.R.S., President, in the chair.—Lieut.-Colonel Allan Cunningham, R.E., read a paper entitled "On Aurifeuillians." These are defined as the *algebraic prime factors* of two functions, viz.: of $(X^{2n} + Y^{2n})$ when $2nXY = \square$, and of $(X^n + i^{n+1}. Y^n)$ when $nXY = \square$, where n is *odd*, and $i = \sqrt{-1}$. Their salient property (discovered by Mr. Aurifeuille, of Toulouse) is that they are *algebraically* resolvible into two factors (say L, M). Also L, M are expressible in the same 2^{ic} forms as their product-function. The quotient of one Aurifeuillian by another of the same order has the same properties. The properties of the two Aurifeuillians of orders 2 and 3, viz.:

$$(x^4 + 2^2y^4) \text{ and } (x^6 + 3^3y^6) \div (x^2 + {}^3y^2),$$

were stated at some length. The application to Fermat's numbers $(2^{4\nu+2} + 1)$ and $(3^{6\nu+3} + 1)$ was given, and a table of the factorisation thereof into *prime* factors was given, extending (with gaps) to $(2^{210} + 1)$, $3^{105} + 1)$. In opening the discussion on the paper, Mr. Bickmore pointed out that Aurifeuille's formulæ, which were enunciated without complete proof by Lucas, might be completely proved by the theory of complex integers. Thus the formulæ express the algebraical prime-factor of $a^n - (-1)^{\frac{n-1}{2}} b$, of n as the difference of two squares, when n is an uneven integer, and $\frac{ab}{n}$ is a perfect square. But the algebraical prime-factor is the norm of the binomial n^{ic} integer

$$a - (-1)^{\frac{n-1}{2}} b\rho^2,$$

which, when

$$a = x^2 \text{ and } b = ny^2,$$

is equal to

$$\left\{x - (-1)^{\frac{n-1}{4}} y\rho\sqrt{n}\right\} \times \left\{x + (-1)^{\frac{n-1}{4}} y\rho\sqrt{n}\right\}.$$

Gauss's results give

$$(-1)^{\frac{n-1}{4}} \sqrt{n} = f(\rho),$$

a rational integral function of ρ; hence, finally,

$$N_n\left\{x^2 - (-1)^{\frac{n-1}{2}} ny^2\rho^2\right\} = N_n\{x - y\rho f(\rho)\} \times N_n\{x + y\rho f(\rho)\}.$$

The formulæ also express as the difference of two squares the algebraical prime-factor of $a^{2n} + b^{2n}$, when n is an uneven integer, and $\frac{ab}{2n}$ is a perfect square; in this case the final result is

$$N_n(x^4 + 4n^2y^4\rho^4) = N_n\left\{x^2 - 2ny\rho f(\rho) + 2(-1)^{\frac{n-1}{2}} ny^2\rho^2\right\}$$
$$\times N_n\left\{x^2 + 2ny\rho f(\rho) + 2(-1)^{\frac{n-1}{2}} ny^2\rho^2\right\}.$$

Kummer's tests show that if n be > 3, the absolute term in each of the complex integers is correctly fixed; hence, y being a factor of every term except the absolute term, if either Aurifeuillian factor be a prime, it has any prime factor of y as a residue of order n, when $n > 3$. The process also expresses complex n^{ic} integers with *more* terms than two, which are expressible in the form

$$x^2 - (-1)^{\frac{n-1}{2}} ny^2,$$

(x and y being themselves complex integers of order n) as the product of two complex n^{ic} integers.—The President (Lieut.-Colonel Cunningham, *pro tem.* in the chair) communicated a paper by Mr. J. E. Campbell on the transformations which leave the lengths of arcs on any surface unaltered. The object of the paper was to obtain the infinitesimal transformations which have the property of leaving unaltered the lengths of arcs on any given surface in space of $n + 1$ dimensions—that is, the transformations which leave $dx_1^2 + \ldots + dx_n^2 + dz^2$ invariant where $z = f(x_1 \ldots x_n)$. It is remarkable that this problem can be solved completely when $n > 2$, though not when $n = 2$. At the conclusion of the paper it is proved that if H is the Hessian of $f(x_1 \ldots x_n)$, then

$$H \div \left\{1 + \left(\frac{dy}{dx_1}\right)^2 + \ldots + \left(\frac{dy}{dx_n}\right)\right\}^{\frac{n+2}{2}}$$

is an invariant for such substitutions; this is a generalisation of the well-known theorem that the measure of curvature (on a surface in ordinary space) is unaltered by transformations which leave the lengths of arcs invariant.—Mr. Hargreaves made a short impromptu communication.

Zoological Society, February 15.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—A letter was read from Mr. Dudley Le Souëf, of Melbourne, containing a summary of some observations on the transfer by the mother of an embryo kangaroo (*Macropus giganteus*) by her mouth into her pouch.—A report was read, drawn up by Mr. A. Thomson, the Society's head-keeper, on the insects exhibited in the insect-house during the year 1897, and a series of the specimens was exhibited.—The Secretary exhibited a series of specimens of butterflies, which had formed part of a collection lately on view at the Dunthorne Gallery, in illustration of the mode of mounting employed in "Denton's Patent Butterfly Tablets."—Mr. W. P. Pycraft read the first of a series of contributions to the osteology of birds. The present part (of which the following is an abstract) related to the Steganopodes. The fact that in the tropic-birds, cormorants, gannets, and frigate-birds, all the toes are united by a common web, has led to the belief that these forms are closely related; they form the sub-order *Steganopodes* or *Totipalmatæ* of authors. A comparison of the osteology of the group confirms this opinion.—Dr. W. G. Ridewood read a paper on the skeleton of regenerated limbs of the midwife-toad (*Alytes obstetricans*). He demonstrated the possibility of the development, in the regenerated hind limb of the larva, of tarsal, metatarsal, and phalangeal cartilages identical in every respect with those of the normal limb.—Mr. G. A. Boulenger,

F.R.S., described a new species of sea-snake from Borneo, which he proposed to name *Hydrophis floweri*, after Mr. Stanley Flower, its discoverer. Mr. Boulenger also gave an account of the reptiles and batrachians lately collected by Mr. W. F. H. Rosenberg in Western Ecuador. Seventy-seven species were enumerated, of which twenty-three, viz. eleven reptiles and twelve batrachians, were described as new.

CAMBRIDGE.

Philosophical Society, January 24.—Mr. F. Darwin, President, in the chair.—A new method in combinatory analysis with applications to Latin squares and associated questions, Major P. A. Macmahon, R.A., F.R.S. The author applies the theory of symmetric functions to obtain solutions, hitherto unachieved, of problems in combinatory analysis associated with the question of Latin squares.—On Abelian functions in connection with two-dimensional fluid motion, H. F. Baker.—On the production of a cloud by the action of ultra-violet light on moist air, C. T. R. Wilson. If the light from an arc lamp be brought to a focus, by means of a quartz lens, within a vessel containing moist dust-free air, a bluish fog becomes visible in the course of a few minutes along the path of the light. The cloud particles remain in suspension for hours after the light has been cut off. The phenomenon is shown even in unsaturated air, but the faint blue haze which then develops takes much longer to form. When the radiation is not sufficiently intense to show these effects, a dense fog can still be obtained by bringing about slight supersaturation by expansion. These clouds, unlike those obtained by Tyndall (*Phil. Trans.*, 160, p. 333, 1870) and by Aitken (*Edin. Trans.*, 39, I. p. 15, 1897) by the action of light on various vapours, are due to the ultra-violet rays alone; for if a thin sheet of glass or mica (substances which are opaque to these rays) be interposed, not a trace of fog or rain is formed even when a high degree of supersaturation is brought about by expansion. It is possible that the small particles to which the blue of the sky is due are the result of this action of the ultra-violet rays, of which sunlight, when it first enters our atmosphere, doubtless contains a plentiful supply.—On the use of logarithmic co-ordinates in physics, J. H. Vincent. The paper divides all curves into "translatants" and "non-translatants." As examples of the former, Mr. Boys' chart of wave and ripple velocities is referred to, and an impedance chart is constructed. Non-translatants are not in general suited to this method of plotting. By suitable devices the logarithmic homologue of the equation for the propagation of waves on a frozen sea is drawn, although this is a non-translatant. The paper concludes with suggested uses of tri-dimensional logarithmic coordinates and semi-logarithmic coordinates.—On the diffuse reflection of Röntgen rays, Prof. J. J. Thomson. The paper contains the theory of the electromagnetic effects produced by suddenly setting an electrified body in motion. It is shown that a thin pulse of intense electromagnetic disturbance is generated which travels outwards with the velocity of light. The magnitude of the magnetic force at a point P due to the pulse is when the velocity w of the particle is small compared with the velocity of light equal to $we \sin \theta/2ar$, where $2a$ is the diameter of the particle O, e the change on the particle, r the distance PO, and θ the angle between OP and the direction of motion of the particle. Using the theory of the Röntgen rays given by the author in the *Phil. Mag.*, February 1898, the result just quoted is applied to find the intensity of the radiation scattered when Röntgen rays are incident on a collection of positively and negatively electrified bodies. The intensity of the scattered rays in a direction making an angle θ with the incident ray varies as $(1 + \cos^2 \theta)$. So that the intensity of the scattered light when $\theta = 0$ would be twice that when $\theta = \pi/2$. Photographs taken by the scattered rays in these two positions showed that there was little, if any, difference of intensity in these directions. This result indicates that the scattered Röntgen radiation is probably more nearly allied to fluorescence than to the scattering of light by small particles. Experiments were made on the absorption of the light diffusely "returned" (to use Sir George Stokes' phrase) from lead and platinum by thin sheets of platinum and red lead; these showed that there was no strong selective absorption by thin platinum of rays scattered from platinum, or by lead of rays scattered from lead. A mathematical investigation is given to show that in the case of rapidly damped radiations selective absorption would not be exhibited.

PARIS.

Academy of Sciences, February 14.—M. Wolf in the chair.—On certain singular examples of successive approximations, by M. Émile Picard.—On the masses of the planets, by M. E. Roger.—Remarks on a note by M. Anceaux. Of the three laws given in this note, the first only is rigorously exact, the second is an approximation, and the third a consequence of the two others.—*Résumé* of the solar observations made at the Royal Observatory of the Roman College during the second half of 1897, by M. P. Tacchini. Observations are given for the distribution of sunspots, protuberances, and faculæ.—On the extension of the decimal system to the division of the day and the circle; advantages and practical methods, by M. J. de Rey Pailhade.—On the singular Abelian functions, by M. G. Humbert.—On some general algorithms, and on iteration, by M. Lémeray.—On the surfaces which admit an infinite, discontinuous group of birational transformations, by M. P. Painlévé.—Deformation of metals, by M. Mesnager.—Direct measurement of the period of the Hertzian oscillations, by M. L. Décombe. Photographs of the explosive spark from a revolving mirror showed that it is possible to fix on a gelatino-bromide plate oscillations of which the period is less than a five-millionth of a second. The necessary conditions were a very high velocity of rotation of the mirror, the employment of a collimating lens, in the focal plane of which the spark is placed, of very small focal length. The results obtained confirmed the theory of Poincaré and Bjerknes, according to which the radiations emitted are of one wave length only.—Emission of secondary rays in air under the influence of the X-rays, by M. G. Sagnac. It is shown experimentally that air through which the X-rays are passing gives off secondary radiations capable of affecting an electroscope. This phenomenon is comparable to the emission of light by a liquid containing a small quantity of a fluorescent substance in solution during the passage of a luminous bundle.—On a new contact-breaker for induction coils, by M. V. Crémieu. The ordinary form of contact-breaker used in induction coils is attended with the inconvenience that the oppositely induced electromotive forces are not symmetrical. This difficulty is overcome by the apparatus described, but at the expense of a larger amount of energy, since to obtain a spark of a given length the electromotive force of the primary circuit must be double that required by the ordinary form.—On a crystallised hydride of dicamphene, by MM. A. tard and G. Meker The dry hydrochloride of terebenthene is fused and sodium added; a hydrocarbon $C_{20}H_{34}$ can be obtained from the product of the reaction. It is noteworthy as being one of the few terpenes obtainable in the crystallised state.—Action of cyanamide upon bromanil in presence of potash, by M. H. Imbert. The substance obtained appears to be the potassium salt of dicyanimino-dibromo-dioxyquinone.—Researches on organic phosphorus, by M. J. Jolly. The experiments given tend to show that phosphorus does not exist in the organic molecule in an unoxidised state.—The production of carbon monoxide in the blood after inhalations of chloroform, by M. L. de Saint-Martin. In attempting to confirm the statement of MM. Degrez and Nicloux that prolonged inhalation of chloroform produces carbon monoxide in the blood, the author finds that normal blood, treated in a vacuum at 40°, with an organic acid, also gives off small quantities of carbon monoxide —On the oxydase of *Botrytis cinerea*, by M. J. Laborde. A study of the effect of this oxydase upon the fermentation of grapes, with especial reference to the decolorisation of the wine.—Tuberculosis and pseudo-tuberculosis, by MM. Bataillon and Terre. The authors have previously described a form of the tubercle bacillus capable of existing in cold-blooded animals, such as the frog. A third form of this bacillus, originally human, has now been obtained after a passage of three days in the frog. On solid media this form grows rapidly at temperatures between 12° and 48°, and is distinguished from the form previously described by three points: appearance of cultures, power of easily developing at high temperatures, and rendering beef-broth turbid. The colonies on the potato are brownish, and the bacilli are not stained by the methods of Gram or Ehrlich. Experiments on animals led to the conclusion that many cases of pseudo-tuberculosis are in reality true tuberculosis, having as a cause one of the numerous forms of Koch's bacillus.—The parasites of cancer and sarcoma, by M. F. J. Bosc. As a result of the examination of numerous tumours it was found that the abnormal formations foreign to the tissues could be grouped under five morphological types: microbial forms, granulations, cellular forms of very variable origin, encysted

forms and sarcodic forms. All these forms exist in epithelioma, carcinoma and sarcoma, but the last-named contains especially the microbial forms and the granulations.—Remarks on the Bloch-appendices in the siluroids of genus *Aspredo*, by M. Léon Vaillant.—On the place of the sponges in classification, by M. Yves Delage.—Influence of the X-rays on germination, by MM. Maldiney and Thouvenin. From experiments upon *Convolvulus arvensis*, *Lepidium sativum*, and *Panicum miliaceum*, it would appear that the X-rays hasten germination.—The melanosis of the mandarin orange, by M. Trabut.—Detection and rapid estimation of manganese in plants and vegetable earths by a colorimetric method, by M. P. Pichard. The method is based upon the ignition of the ash with an alkaline carbonate, and subsequent formation of permanganate by the use of lead peroxide and nitric acid.—On the conglomerate of the Amône in the Swiss Ferret valley, by MM. L. Duparc and F. Pearce.—On the formation of anhydrite by the calcination of gypsum at high temperatures, by M. A. Lacroix.—On the origin of the overlapping layers in the region of Ubaye, by MM. W. Kilian and E. Haug.—On some phenomena of fluvial erosion and corrosion, by M. Jean Brunhes.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 24.

ROYAL SOCIETY, at 4.30.—Meeting for Discussion.—Subject: The Scientific Advantages of an Antarctic Expedition. The Discussion will be opened by Dr. John Murray, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—On the Manufacture of Lamps and other Apparatus for 200 volts Circuits: G. Binswanger, Byng.

FRIDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 9.—The Theory of Colour Vision applied to Modern Colour Photography: Captain W. de W. Abney, C.B., F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Problem of Train Resistance: C. E. Wolff.

SATURDAY, FEBRUARY 26.

ROYAL INSTITUTION, at 3.—The Structure of Instrumental Music: W. H. Hadow.

PHYSICAL SOCIETY (Eton College), at 4.—The Rev. T. C. Porter will describe (1) a New Theory of Geysers; (2) a New Method of Viewiug Newton's Rings; (3) Experiments bearing on the Sensation of Light; (4) a Method of Viewing Lantern Projections in Stereoscopic Relief; (5) Winter Observations on the Shadow of El Teide, with a New Method for Measuring approximately the Diameter of the Earth; (6) Temperature of the Water of Niagara.

MONDAY, FEBRUARY 28.

SOCIETY OF ARTS, at 8.—The Principles of Design in Form: Hugh Stannus.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Annual Range of Temperature in the Surface Waters of the Ocean, and its Bearing on Oceanographical Problems: Dr. John Murray, F.R.S.

INSTITUTE OF ACTUARIES, at 5.30.—The Relation of the Actuarial Profession to the State: J. Nicoll.

TUESDAY, MARCH 1.

ROYAL INSTITUTION, at 3.—The Simplest Living Things: Prof. E. Ray Lankester, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—On the Perforate Corals collected by the Author in the South Pacific: J. Stanley Gardiner.—The Myology of the Terrestrial Carnivora, Part 2: Prof. B. C. A. Windle and F. G. Parsons. On the Brain and some other Points in the Anatomy of *Bassaris*: F. E. Beddard, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Papers to be further discussed: The Theory Design, and Practical Working of Alternate-Current Motors: Llewelyn B. Atkinson.—Dublin Electric Tramway: H. F. Parshall.

RÖNTGEN SOCIETY, at 8.—Photographic Activity and Penetration of Röntgen Rays at Different Vacua: J. H. Gardiner.—Other Papers by Wilson Noble and Hall Edwards.—Mr. Isenthal will show some New Apparatus.

WEDNESDAY, MARCH 2.

SOCIETY OF ARTS, at 8.—Kites: their Theory and Practice: Captain B. F. S. Baden-Powell.

THURSDAY, MARCH 3.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Relationship of Variations of the Ground Water Level to the Incidence of Malarial Fevers in Chotta Nagpur, Bengal: Dr. L. Rogers.—On the Depletion of the Endosperm of *Hordeum vulgare* during Germination: H. T. Brown F.R.S., and F. Escombe.—Experimental Observations on the Early Degenerative Changes in the Sensory End Organs of Muscles: Dr. F. E. Batten.

ROYAL INSTITUTION, at 3.—Recent Researches in Magnetism and Diamagnetism: Prof. J. A. Fleming, F.R.S.

LINNEAN SOCIETY, at 8.—On the Sense Organs of the Lateral Line in certain Fishes: F. J. Cole.—On the Occurrence of *Carex helvola* in Britain: G. C. Druce.—On Arctic Spiders from Franz Josef Land: Rev. O. Pickard-Cambridge.

CHEMICAL SOCIETY, at 8.

FRIDAY, MARCH 4.

ROYAL INSTITUTION, at 9.—Some Recent Results of Physico-Chemical Inquiry: Prof. T. E. Thorpe, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Andrée and his Balloon: H. Lachambre and A. Machuron (Constable).—Year-Book of the Royal Society, No. 2, 1897–98 (Harrison).—Meteorology in Mysore, 1896: J. Cook (Bangalore).—Magnets and Electric Currents: Prof. J. A. Fleming (Spon).—Twenty-fourth Annual Report of the Local Government Board, 1894–95. Supplement: Inland Sanitary Survey, 1893–95 (Eyre).—Report of the Meteorological Service of the Dominion of Canada, 1890 and 1895: R. T. Stupart (Ottawa).—Storm and Sunshine in the Dales: P. H. Lockwood (E. Stock).—Pike and Perch: A. Jardine (Lawrence).—The Kingdom of the Yellow Robe: E. Young (Constable).—Lessons with Plants: L. H. Bailey (Macmillan).—Through China with a Camera: J. Thomson (Constable).—Proceedings of the London Mathematical Society, Vol. xxviii. (Hodgson).—Leçons sur l'Intégration des Equations: E. Goursat, 2 Vols. (Paris, Hermann).—Œuvres Scientifiques de L. Lorenz, Tome 1, Deux Fasc. (Copenhague, Lehmann).—A Treatise on Universal Algebra, with Applications: A. N. Whitehead, Vol. 1 (Cambridge University Press).—Peneroplis: F. Dreyer (Leipzig, Engelmann).

PAMPHLETS.—The Twelfth and Concluding Memoir on the Theory of Screws: Sir R. Ball (Dublin).—Die Geometrisch-Optischen Tänschungen: W. Wundt, No. 2 (Leipzig, Teubner).—A Suggested Improvement of the Current Theories of the Tides: J. H. S. Moxly (Rivingtons).—Vaccination a Delusion: Dr. A. R. Wallace (Sonnenschein).

SERIALS.—National Geographic Magazine, January (Washington).—Monthly Weather Review, November (Washington).—Zoologist, February (West).—Proceedings of the Bristol Naturalists' Society, new series, Vol. viii Part 2 (Bristol).—Studies from the Yale Psychological Laboratory, Vol. 4, 1896 (New Haven).—Journal of the Franklin Institute, February (Philadelphia).—Astrophysical Journal, January (Chicago).—Journal of the Chemical Society, February (Gurney).—American Anthropologist, November and December (Washington).—Proceedings of the Indiana Academy of Science 1896 (Indianapolis).

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THURSDAY, MARCH 3, 1898.

ARCHIMEDES.

The Works of Archimedes. Edited in Modern Notation, with introductory Chapters by T. L. Heath, Sc.D., sometime Fellow of Trinity College, Cambridge. Pp. clxxxvi + 326. (Cambridge: at the University Press, 1897.)

THIS is a companion volume to Dr. T. L. Heath's valuable edition of the "Treatise on Conic Sections" by Apollonius of Perga, and the same patience, learning and skill which have turned the latter book into a delightful guide to early Greek geometry have been here applied to present in a most readable form the extant works of perhaps the greatest mathematical genius that the world has ever seen. The same general plan of editing has been followed in this book as in that of Apollonius, such condensation and modernisation having been introduced as is possible without alteration of the methods employed. We consequently now possess for the first time in English dress a reproduction of Archimedes' work, without addition or essential omission, from which have been removed the thorns and briars that have hitherto beset the path of the English student who would make himself acquainted with the methods invented and employed by the extraordinary genius of Archimedes in order to make those measurements which now-a-days are rendered easy only by the use of the integral calculus. Not the least deterrent of these obstacles have been the Doric dialect of parts of the original and the abbreviations and corruptions in which the text of the accessible editions abounds, so that hitherto the French translation by Peyrard, or that in German by Nizze, has been preferable for the purposes of study.

The volume itself is a handsome example of mathematical printing such as we are wont to expect from the Cambridge University Press, and it is most fitting that it should have been issued by that Press, since Torelli's standard edition (in Greek with a Latin version) was published by and at the expense of the sister University under the editorship of Prof. Abram Robertson, D.D., of Christ Church.

The book will do much to restore Archimedes to his proper place in the estimation of mathematicians; for, in spite of the admirable histories of mathematics that lie to our hand, Archimedes is scarcely known at all except as the discoverer of an important principle in hydrostatics, or the constructor of a spiral, or the inventor of a screw, or the destroyer of ships by the use of a mirror. Indeed it is but little known that in his books on Equilibrium he laid the foundation of theoretical mechanics, and that in his treatises on Floating Bodies he created the science of hydrostatics; that he it was who discovered $3\frac{1}{7}$ as a superior limit of the ratio of the circumference of a circle to its diameter, and $3\frac{10}{71}$ as a still closer lower limit; that to him we owe the quadrature of the conic sections and of the surfaces generated by their revolution, as well as the cubature of the volumes so formed; or that he was the author of a system of representing numbers up to that which would now be expressed by 1 with eighty thousand million millions of cyphers following it. What else he may have done we do not know for certain, as our information rests on vague accounts by later authors; but eight at least of his published works are lost, and these cannot but have shown the same originality and been marked by the same presentation of new truths as those which have survived, while none of them, or of those that we have, relate to his numerous mechanical inventions, of which in comparison with his mathematical speculations he seems to have thought meanly since, in Plutarch's words, he would not deign to leave behind him any written work on such subjects.

Not the least important part of this book is the introduction of 186 pages which precedes the 326 pages of text. This contains a very valuable discussion of the problems that attracted the attention of the early Greek geometers, and also a most interesting account of the various suggestions that have been put forward as to the mode in which Archimedes obtained certain results which he states without entering into details respecting them.

After a preliminary recital of the stories told of Archimedes by ancient writers, and a short account of the ingenious mechanical inventions they have attributed to him, Dr. Heath discusses the MSS. sources of the text that survive, and enumerates with slight details the principal editions of their text that have been published. From this we learn all that is really needful, though the Latin version with commentary made by Abbot Maurolycus in 1534–49, and published at Palermo in 1685 by Cyllenius Hesperius, also deserves notice. One might further remark that if the titles of the different editions are given at all in anything like fullness, they should be given with absolute exactness, and this is not done in any of the Latin versions save those of Torelli and Heiberg.

Then follows an excellent chapter upon the relation of Archimedes to his predecessors, and this is full of interest not only historically, but also as contrasting Archimedes' methods with those of others, and illustrating his extraordinary facility in the manipulation of proportions, a special instance of which is, in modern notation, the elimination of b, c, d from the conditions $a/b = b/c = c/d > 1$, $3d(a - c) = 5x(a - d)$, $(a - c)(2a + 4b + 6c + 3d) = 5y(a + 2b + 2c + d)$. Next comes a clear account of the Greek system of numerals and the Greek modes of performing arithmetical operations, more especially with reference to the approximations to the square roots of numerics which are not squares; but in this last matter there is plenty of room for conjecture, as not much direct information is available, and Dr. Heath gives a fairly exhaustive account of what has been written on the subject. The fifth chapter treats of the problems known as νεύσεις, which deal with the straight lines that have to verge towards a given point, and fulfil some other condition too; these have not much to do with Archimedes, but they are exceedingly interesting, and without their discussion a study of Greek geometry would be incomplete. The Greek methods of geometrically solving problems that practically involve cubic equations are next unfolded at length, and a discussion of the classification of problems and loci as plane, solid and (curvi-) linear completes a most interesting chapter. Finally Archimedes' anticipations of the integral calculus

by an admirable extension of the method of exhaustion are considered, and copiously illustrated; and the introduction concludes with a most useful account of the mathematical terms and phraseology employed by Archimedes.

Dr. Heath's general treatment of the text is excellent, but there is one point on which we do not think that he has exercised a sound judgment. This is the renumbering of the propositions in three of the books, which renders reference to them a matter of entire uncertainty. Thus the celebrated Prop. 37 of Book I. on the Sphere and Cylinder, which gives $\frac{2}{3}$ as the ratio of the surfaces and of the volumes of a sphere and the cylinder that just contains it, appears in Dr. Heath's book as a corollary of Prop. 36, which is numbered 34; he further puts Props. 33, 43, 45, 46 as corollaries, and includes Prop. 1 in the introductory letter, thus reducing to 44 the 50 propositions of the MSS. In Book II. he treats Prop. 1 similarly, even though Archimedes himself, in the introductory letter to his work on Spirals (p. 152), mentions this proposition as the first of those which were proved in this book. In the book on Conoids and Spheroids he further puts as a Lemma what appears as Prop. 1 in all the Greek and Latin texts, so that the famed Prop. 12 on certain plane sections of these figures, the characters of which are said by Archimedes to be φανεραί, appears as Prop. 11, and Prop. 18 is put as the third part of Prop. 17 (numbered 16)—without any reason, since it is not an extension of, though deducible from, the other parts.

Complete as the book is, there is one addition that would be welcomed by all students, viz. a table of all the writers named, and of the approximate dates at which they flourished; this, if of easy reference, would be of great help when the relation of different geometers to any problem was under consideration. A larger number of references is also desirable in the interests of the student who is stirred to go to the fountain-head by his thirst for first-hand information. Thus the proofs on pp. liv–lviii of the above-cited Prop. 12 on Conoids and Spheroids are so introduced, especially in being contrasted with Zeuthen's, as to appear to be quite modern, while really being contained in Torelli's edition, and practically also in the earlier editions of Maurolycus and Rivaltus.

We feel much inclined to challenge Dr. Heath's rendering of Euclid's definition of a straight line in his note on p. 3, and to maintain the correctness of the ordinary version of it. The special point seems to us to lie in the word ἐπί, "on," the use of which seems to be due to the thought in the writer's mind of points marked by letters over the line; thus Aristotle ("Ethics," v. 4, 12) writes ἴσαι αἱ [*i.e.* γραμμαί] ἐφ' ὧν AA, BB, ΓΓ ἀλλήλαις where the sentence can only mean "the lines AA, BB, CC are equal to one another"; the words must therefore mean "the lines are equal over the two ends of which A and A, B and B, C and C are written," so that Euclid's τὰ ἐφ' ἑαυτῆς σημεῖα must mean "its own extreme points."

Such slight blemishes, however, or what we deem to be such, do not detract from the very great value of this work, and Dr. Heath deserves our grateful thanks for the labour he has expended upon it. It is a fitting addition to his former task; for as, to quote Charles, in Apollonius work we find the origin of the geometry of Forms and Situations as it is now developed, so in the present book we are introduced to the basis of the geometry of Measurement which has demanded a new calculus for its perfection.

R. E. B.

A NEW TEXT-BOOK OF EXPERIMENTAL PHYSIOLOGY.

The Essentials of Experimental Physiology. For the use of Students. By T. G. Brodie, M.D., Lecturer on Physiology, St. Thomas's Hospital Medical School. Pp. xiv + 231. (London: Longmans, Green, and Co., 1898.)

THIS volume appears in the same series as two books already well known to the medical student of this country, viz. Schäfer's "Essentials of Histology" and Halliburton's "Essentials of Chemical Physiology." It is bound uniformly with these two volumes, but on opening the books all resemblance disappears. Instead of being divided into a number of "lessons," each of suitable length for one day's work of a practical class, the new volume is divided into "chapters" the length of which bears no proportion to the practical work of a class-meeting. In the other two volumes of the series, each lesson is commenced by a concise and definite description for the student of how to perform a number of experiments; and this description is followed by a few pages of theoretical teaching bearing on those experiments. In the present volume this arrangement is departed from, and the experiments are interpolated in a discursive fashion through the text.

An attempt is made to mark off by heavy type a portion of the book as an elementary course, but it is questionable whether this would not have been much better done by dividing the volume into an elementary and advanced course, as has been done by Prof. Halliburton in the "Essentials of Chemical Physiology." Again, some of the experiments described in this elementary portion are quite beyond the reach of the junior student—for example, the maximum work performed during a muscular twitch; while other simple and important experiments, such as the effect of temperature on muscular contraction, are excluded from this part.

The book commences with a description of various forms of galvanic cells and the chemical changes involved in their action. Such a description is scarcely necessary, for the student is supposed to be already familiar with the commoner forms of galvanic cell before commencing practical work in physiology; but, if inserted, it would have been much better to have described the action of the cells correctly. For example, the student who has just attended a junior course of instruction in a physical laboratory will be somewhat disturbed in his notions of electrolysis by being told that when the Daniell's element is in action—

"the chemical changes in the battery are, solution of zinc and formation of $ZnSO_4$ at the zinc plate, and decomposition of the $CuSO_4$, *by the hydrogen appearing at the copper plate* to form H_2SO_4 and metallic Cu, which latter is deposited on the copper surface."

Similarly, in the case of the Bunsen cell the student is informed that, "the H_2 appearing simultaneously at the carbon pole (?) is oxidised into H_2O by the nitric acid." It is surely a new discovery that hydrogen appears at the negative plate in these elements, and one well calculated to upset all present electrolytic hypotheses.

The induction coil and its action are next considered, and here again some mistakes occur.

"The E.M.F. of the induced current depends upon several factors: (1) It is directly proportional to the intensity of the current change in the first wire. (2) It is directly proportional to the rate of change of the inducing current."

It is difficult to see any difference between (1) and (2); there is probably a misprint somewhere, but this is precisely the kind of blunder most calculated to waste the time and temper of a student who is not strong in physics. In describing the theory of the extra currents of make and break it is stated that—

"as the duration of this induced current (the extra current at make) is very short its effect is soon exhausted, but not before it has produced the result that more time is required for the current to reach its full strength than would have been the case if the wire had been perfectly straight."

Now the extra current at make lasts just as long as there is any variation of the primary current, and therefore as long as there is any induced current in the secondary coil, and its effect is no sooner over than any of the other effects involved.

A further error in connection with the same subject is worth noting, since it is not peculiar to this volume, but occurs in other text-books of physiology.

"On breaking the circuit the circuit of the primary is broken, so that no induction currents can be set up in the primary."

"The fall in potential is therefore instantaneous."

Now the fall in potential at break is *not* instantaneous, otherwise the E.M.F. of the induced current in the secondary circuit would be infinitely great. The primary circuit cannot by any means be instantly broken, and there *is* an induced extra current in the primary at break. Only in the circuit during break there is a high resistance in the spark gap, and both the extra current and the primary current are rapidly diminished by this rapidly increasing resistance.

The more purely physiological part of the book is fairly well written, and contains descriptions and figures of new and sometimes ingenious adaptations of simple apparatus for experimental work. Some of these artifices for making simple apparatus are certain to become extensively used, and it is here that the book will probably render most assistance to teachers of physiology. The book is also copiously illustrated, and contains a large number of reproductions of experimental tracings. Many of these it is impossible for the student to imitate for himself, but they will doubtless form valuable aids in assisting him to recollect the results of class demonstrations.

OUR BOOK SHELF.

L. Rütimeyer. Gesammelte Kleine Schriften allgemeinen Inhalts aus dem Gebiete der Naturwissenschaft. Nebst einer autobiographischen Skizze. Edited by H. G. Stehlin. 2 vols. 8vo. Pp. iv + 400 and 455. With a portrait and woodcuts. (Basel: Georg et C^ie^, 1898.)

IN these two well-printed and handy volumes we have the more important of the contributions made to science by the late Prof. Rütimeyer, which could be reproduced without costly illustrations. By the kindly care of Leopold Rütimeyer and H. G. Stehlin, we have these as an "In Memoriam" tribute, the crowning stone of which is the very interesting series of notes by Prof. Rütimeyer himself of the chief incidents of his life. In a work of this nature, there is left but little room for criticism, and we will serve the reader's purpose best by a brief notice of the contents of the volumes. In the stray memories of his scientific life we learn that, born in February 1825, his early days were spent in the country; his life was in the open air, wandering over field and meadow, in woods, and up the hill-tops. Educated at home, he records his happiness at having escaped the mischiefs and sorrows of a public school. When sixteen years old, falling under the influence of Bernhardt Studer, his studies took the direction of the natural sciences, and his future career was marked out. In these "Memories" many are the interesting facts recorded in a busy life. As an author he began with a "Memoir on the Nummulitic Region of the Bernese Alps," which was published in 1848, and we have on record a long list, published from year to year, with but few exceptions, until 1895, when in June he put his initials to the "Memories," passing out of the world, though not beyond memory, on the 25th of the following November. Ever fond of nature, his latter years were rendered happier by winter sojourns in the sunny south of Europe.

The memoirs in the first volume are chiefly of a zoological character. We find an essay on the form and history of the vertebrate skeleton; on the historic method in palæontology; on the origin of our animal kingdom; on the limits of the animal kingdom—a critical notice on Darwin's writings; on the alterations in the animal life in Switzerland, since the appearance of man; on the evolution of organic beings. Most of these memoirs were at one time of interest, but while they were, as we think, worth gathering into a volume, it must be confessed that the greater part of their novelty has gone.

The second volume contains a long essay, "Vom Meer bis nach den Alpen," being a sketch of the structure, form and colour of the country met with in a section between England and Sicily; also a paper on the people of the Alps; a glance at the history of glacier studies in Switzerland; a very brightly written sketch of Brittany and its people. Obituary notices of Louis Agassiz, Charles Darwin, Peter Merian, and Bernhardt Studer, bring this volume to an end. There is in an appendix a list of all Rütimeyer's writings, arranged in chronological order.

Recherches expérimentales sur quelques Actinomètres Électro-chimiques. By H. Rigollot, Docteur ès Sciences, Chef des travaux de Physique a l'Université de Lyon. Pp. vi + 138. (Paris: Masson et C^ie^, 1897.)

IN this work M. Rigollot has collected together, in a convenient form, his researches on photo-electric cells. Two metallic plates being immersed in an electrolyte, and the one exposed to light whilst the other is protected from it, a difference of potential is established between them. The author gives the large amount of valuable information, which he has accumulated in his study of this phenomenon, in the form of experimental results;

we cannot but regret the absence of any attempt to formulate a theory of them. The work is divided into three parts; in the first the effects of white light are studied, in the second the different parts of the spectrum are taken separately, and the third contains experiments on the increase of sensibility due to colouring matters. Plates of copper coated thinly with oxide, sulphide, fluoride, bromide and iodide, of tin coated with oxide and sulphide, and of silver coated with sulphide, are examined in solutions of some thirteen different salts.

The electromotive force developed depends on many circumstances, such as the thickness and nature of the coating, the concentration and nature of the electrolyte and the temperature, so that it is difficult to prepare two identical cells. The electromotive force of a given cell is, however, proportional to the intensity of the light when this is not too large. All the elements had a maximum sensibility in some part of the spectrum, the position of the maximum depending on the nature of the coating on the plates, but, for a given instrument, being independent of the nature of the electrolyte. With dyed plates the position of the maximum was independent of the compound of copper employed, but was determined by the nature of the dye, and was always found at a wave-length greater than that for which the colouring matter had a maximum absorption. The sensibility is largely increased by the employment of colouring matters. The actinometers may be employed for photometric purposes, since it is possible to prepare one with a maximum sensibility for almost any wave-length. Since the development of the electromotive force is accurately synchronous with the action of the light, they may also be used as radiophones.

Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus. Edited by Prof. Dr. G. Hellmann. No. 10, Rara Magnetica, 1269–1599; No. 11, Ueber Luftelektricität, 1746–1753. (Berlin: A. Asher and Co, 1898.)

Dr. Hellmann is so well known by his laborious researches in matters relating to the history of early scientific documents and instruments, and by the very valuable bibliographical knowledge which he brings to bear upon the various publications of this nature, that it is unnecessary to say more than that the present volumes exhibit the same painstaking labour as those which have preceded them. The first contains fac-simile copies of some of the earliest papers on terrestrial magnetism and the mariner's compass; each document is very scarce, and only accessible with difficulty, and must be considered as a literary rarity. Among them is a letter from Pierre de Maricourt, dated August 12, 1269, which is the earliest known treatise on magnetism in Europe. The principal point in the paper is the distinction of the two poles of the magnet, and of their opposite attraction. A paper by F. Falero (Sevilla, 1535) contains the first published instructions for determining the magnetic declination, although its existence was discovered by Columbus in 1492. A letter by G. Hartmann, dated March 4, 1544, gives an account of his discovery of the magnetic dip and the first determination of the declination on the mainland. This document was buried in the archives at Königsberg until 1831, so that the discovery of the magnetic dip is generally attributed to R. Norman, who determined it for London in 1576. In a letter from G. Mercator to the Bishop of Arras, which was discovered during the present century in the library at Göttingen, the first mention is made of the earth possessing a magnetic pole. There are various other papers which we cannot refer to here, all of which are of great interest and value in throwing light upon the earliest development of the subject. The second volume contains a reproduction of the first fundamental papers relating to atmospheric electricity. The electrical nature of thunderstorms was suspected early in the eighteenth century by Hauksbee and other Englishmen, but Prof. J. H. Winkler, of Leipzig, first clearly demonstrated the analogy between them and the electric spark in 1746; the experimental proof was proposed by B. Franklin in 1749, and first carried out, near Paris, by Dalibard on May 10, 1752.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Does a Phosphorescent South American Liana exist?

In collecting the literature regarding phosphorescent plants, I chanced on an article, by Mr. C. F. Holder, on "Living Lamps," in No. 392, vol. lxvi. (January 1883) of *Harper's Magazine.* In this article, at page 191, it is said: "In South America, a vine known as the Cipo, when injured, seems to bleed streams of living fire. Large animals have been noticed standing among its crushed and broken tendrils, dripping with the gleaming fluid, and surrounded by a seeming network of fire."

Could any reader of Nature confirm the existence of this Cipo with a phosphorescent sap? Cipo, I believe, is a name for liana, not for vines. If true, the existence of a phosphorescent sap in a superior plant would be of great physiological interest. But no mention of this or a similar case is to be found in the standard works on vegetable physiology. I fear the statement may have as much foundation as the assertion, made in the same article, that among the peasantry of Italy girls complete their gala toilet with diadems of fireflies. Italo Giglioli.

Portici, near Naples, February 18.

Insusceptibility of Insects to Poisons.

Your reviewer's observation that one insect's food is another insect's poison, is applicable to a single insect at different stages of development. The scarlet fungus, *Agaricus muscarius*, derived its name from use in an old-fashioned decoction for fly-papers; nevertheless, it is eaten freely by maggots. Other poisonous fungi, such as *A. æruginosus*, *A. phalloides*, *Russula emetica*, &c., are evidently innoxious to maggots and slugs. With regard to the effect upon more highly organised animals, it may be noted that *Boletus luridus* is eaten by mice and rabbits, and that squirrels are very partial to several species of *Tricholoma* and *Boletus*. I have some doubt as to whether squirrels are not occasionally poisoned by eating fungi, but I have not noticed any suspicious mortality in the case of the rabbits or mice.

February 19. H. B. Potter.

The Mandrake.

In a foot-note to my letter under this heading (Nature, vol. liv. p. 343, August 13, 1896), I quoted from a Chinese work the names of the nine plants reputed to assume frequently the human or animal figures; and I remarked thereon that most of the alleged figures in these plants were recognised in their subterraneous members. Lately, however, I have found this remark not quite correct, inasmuch as it concerns some of them, viz. mustard and turnip: the alleged figures in these two appear to have suggested themselves to the Chinese imagination by the deformities in their floral parts caused by some parasitic infestations. This is evident from the following passage that occurs in "Mung-ki-pih-tan," written by Chin Kwoh (1031–94 A.D.): "When such vegetables as the turnips and mustard are injured by draught, their inflorescences mostly form the blossoms resembling the lotus-flower, or like the dragon and serpent. These are of common occurrence, and anything but wonderful. Once in the period of Hi-ning (1068–77 A.D.), when Mr. Li Kih-chi was the governor of Jun-chau, all blossoms of the vegetables in his garden happened to have the form of the lotus-flower, each having one Buddha sitting in it. They were innumerable, and looked as if engraved, and well preserved the figures after desiccation. Some one used to ascribe this ominous event to the great zeal with which all members of Mr. Li's family devoted themselves to the worship of Buddha."

February 21. Kumagusu Minakata.

ANTARCTIC RESEARCH.

THE desirability of a well-equipped expedition for the study of the Antarctic regions has been so frequently set forth by men of science, and recorded in the columns of NATURE, that little can now be said on the subject without repetition. But if little that is new can be said, much remains to be done; and unless the unanimous and often repeated declarations of British scientific men culminate in action, the reputation of science in this country will suffer seriously. The large and enthusiastic meeting of the Royal Society on Thursday last, February 24, showed more emphatically than had before been possible how great is the importance attached to the renewal of Antarctic exploration by the leaders of all departments of natural science. The meeting is fully reported below; but the steps which have led to it, and the reasons why the goal has not sooner been attained, may be referred to here.

Sir Wyville Thomson, on the return of the *Challenger*, and of the Arctic expedition which followed it, came to the pessimistic conclusion that "we can only anticipate disasters multiplied a hundred-fold should the South Pole ever become a goal of rivalry among the nations" (NATURE, xv. p. 123); but much has been learnt as to methods of polar travel since 1876, and the fear of possible disaster was, we believe, never strong enough to check any British scientific expedition. Dr. Neumayer had several years previously very strongly urged the importance of Antarctic work on many grounds (NATURE, vii. p. 21), and to him, more than to any other, is the recent revival of interest due. As early as 1875 the question was seriously raised in Australia, though not pressed.

At the British Association meeting in 1885 Sir Erasmus Ommanney urged the advisability of renewing Antarctic exploration, and a Committee was appointed to consider the matter. As a result the Royal Society of Edinburgh and the Scottish Geographical Society appointed Committees to draw up reports in 1886, which were published as an appendix to a paper on Antarctic exploration, by Dr. John Murray, in the *Scottish Geographical Magazine*, vol. ii. p. 527. At the Birmingham meeting of the British Association in 1886, a Report was presented stating the importance of a Government expedition, and Captain Creak, R.N., read a paper giving forcible expression to the necessity of research in the Far South from the point of view of terrestrial magnetism. The Australasian Colonies became keenly interested, and the Legislature of Victoria actually voted 5000*l*. to assist in an expedition if the Imperial Government would also take part in it. The Manchester meeting of the British Association in 1887 again considered the question, and at Bath in 1888 Sir Erasmus Ommanney's Committee gave in a final report expressing regret that Her Majesty's Government had declined to support the Australian proposals; which they did on the ground that if successful a more expensive expedition would be called for. During the year 1891 an effort was made in Australia to initiate a joint Australian and Swedish expedition, but without result, and financial difficulties afterwards prevented the renewal of Australian offers. At the Fifth International Geographical Congress at Bern, and at the British Association at Cardiff, papers were read by Sir Erasmus Ommanney and Mr. Delmar Morgan on the advisability of getting up an expedition. In 1892 a new phase of the question was entered upon. Whaling expeditions to the seas south of the Falkland Islands were despatched from Dundee and from Norway. Thanks to the efforts of Mr. Leigh Smith and the support of the Royal Geographical Society, the *Balæna* and *Active*, of Dundee, were supplied with instruments, and their surgeons, Messrs. Bruce and Donald, were selected with a view to making scientific observations. Captain Larsen, of the Norwegian whaler *Jason*, also made good observations. They returned in 1893, and the results, although not very striking, were sufficient to show the necessity for finding out more, and the comparative ease with which steam vessels could navigate Antarctic waters. The British Association again appointed a Committee, which reported in 1894.

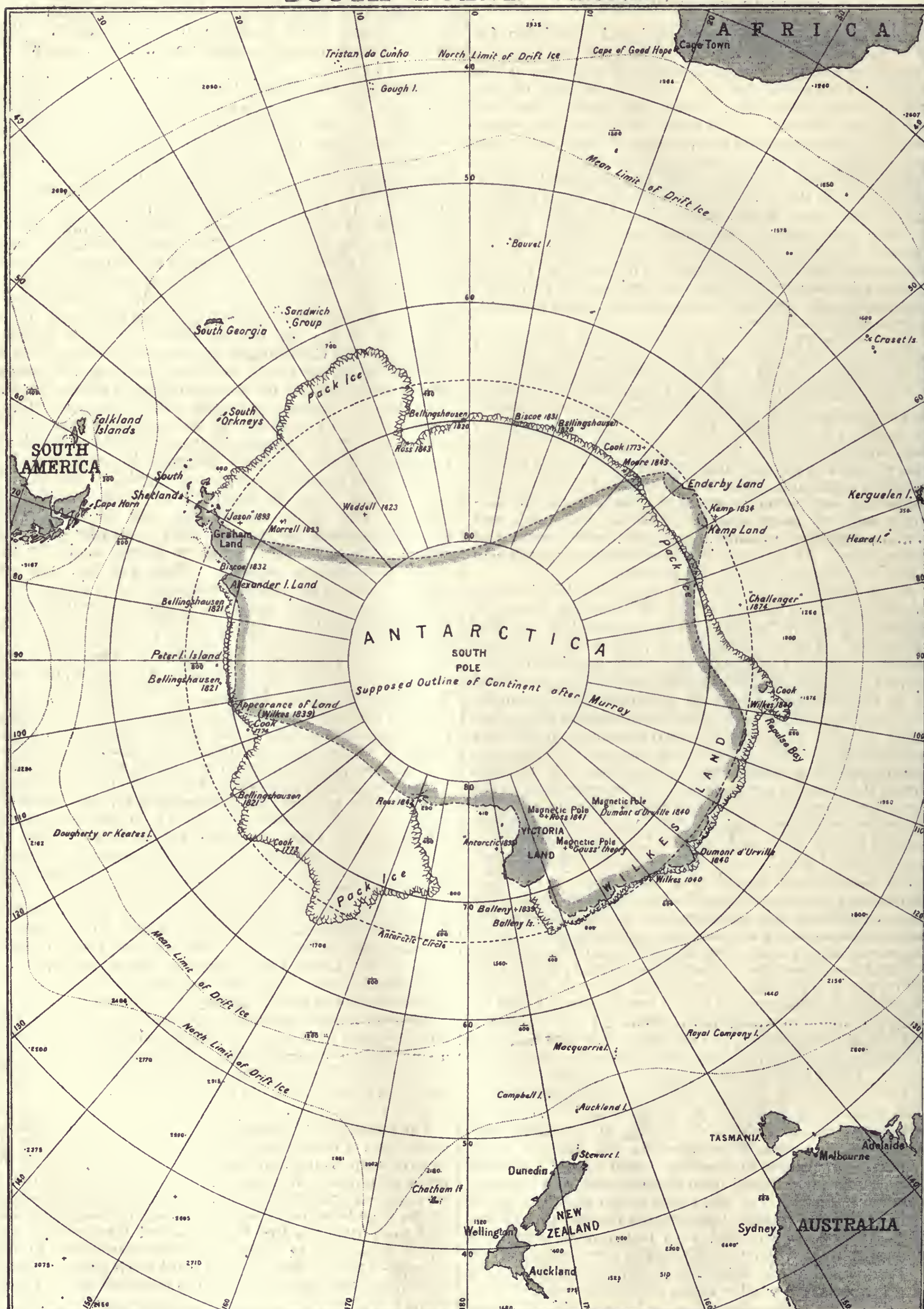
Meanwhile the Royal Geographical Society invited Dr. John Murray to bring the subject forward, which he did by an address at an evening meeting in November 1893. Interest in the question has been kept up ever since. Sir Clements Markham and other geographers have never ceased to urge by lectures, and articles in the press, the necessity of renewing exploration. In 1894 the representations of the Royal Geographical Society's Antarctic Committee induced the Royal Society to appoint a Committee which, after pronouncing in favour of a Government expedition, sought an interview with the authorities at the Admiralty. A recent article in the *Times* describes the result—"A deputation from the Royal Society waited upon the first Lord of the Admiralty to lay the matter before him; but another member of the Government intervened and informed the deputation that Sir James Ross, fifty years ago, had done all that was necessary for the exploration of the Antarctic."

In 1895 the Norwegian whaler *Antarctic* reached Cape Adare, where Kristensen and Borchgrevink landed. A conference of the greatest interest was held at the Sixth International Geographical Congress in London, and a resolution of enthusiastic approval carried. The British Association's Council reported, at their meeting in Ipswich, that after considering the question "the Council resolved to express their sympathy with and approval of the effort which is being made by the Royal Geographical Society." This was but cold encouragement, as the Association proposed to do nothing; but the promoters of Antarctic research were not at any time baffled by the ice-barriers of officialism, and efforts to compel attention to the scheme were renewed. The Royal Society appointed December 12, 1895, for a discussion on the scientific aspects of the case, to be introduced by Dr. John Murray, and arrangements were made in the same month for a deputation, representing the scientific societies of the United Kingdom, to wait on the First Lord of the Admiralty. He intimated that it would be inconvenient to receive it, on the ground of the small strength in officers of the British Navy making it impossible to spare the few required for an expedition. Circumstances led to the discussion being also postponed.

Throughout 1896 energetic efforts were made by various private individuals to get up commercial expeditions to the Antarctic regions, but without success. During the Jubilee rejoicings in 1897, the Royal Geographical Society seized the opportunity to hold a conference of Colonial Premiers and others, in the hope of reviving Australian offers of co-operation; and, encouraged by the result, the Society appealed once more to Government, not this time to the First Lord of the Admiralty, but to Lord Salisbury. It is understood that this representation is now under sympathetic consideration; and the great meeting at Burlington House has come at a singularly appropriate time. We may be sure that the unanimous voice of that meeting cannot be disregarded; and if an expedition is not now arranged, there must be a serious reason for it.

The demand for Antarctic research is no sudden impulse on the part of men of science; it originated independently in several quarters, and was not taken up by any of the great societies until it had been made quite clear that it was earnest and widely based. In Germany the agitation for an expedition has resulted in a nearly completed plan, and from Belgium the *Belgica* sailed last summer, and is, we hope, now at work in the southern ice. In July next Sir George Newnes will send out a private expedition under Mr. Borchgrevink, the work of which is sure to be full of interest. The Royal Geographical Society

SOUTH POLAR CHART



also could easily have arranged for a small expedition under competent leadership, had it not felt that preliminary work is not now so much wanted as substantial and sustained research, the expense of which would be too great for an individual or a society, though trifling to a nation. A large expedition is necessary, and a vast amount of anxiety and uncertainty as to the manner of working would be spared if it could sail under naval discipline, like the *Challenger*. There must be no mixture of commercial with scientific interests: when the conditions of the region are investigated, and its resources tested, private enterprise will not be slow to take practical advantage of useful discoveries. The incidental scraps of scientific value which commercial cruises have produced are undoubtedly useful to a certain degree; but scientific men on board vessels of that class have too frequently failed to work smoothly with the executive authorities. The exact relations to be observed between naval officers and civilian scientific staff can be determined in the light of past experience.

The object of Thursday's meeting was to elicit expert opinion as to the scientific advantages likely to be derived from adequate exploration of the South Polar region. In the absence through illness of Lord Lister, Sir John Evans presided, and the meeting-room of the Royal Society was crowded by a remarkable audience. In addition to the leading authorities in London on every branch of science, there were present the three men who have been nearest the two poles, Dr. Nansen and Lieut. Johansen from 86° N., and Sir Joseph Hooker from 78° S., the only survivor of Ross's expedition, and the last man alive who has seen Mount Erebus and the southern Ice Barrier. Dr. Neumayer, of the Deutsche Seewarte, came from Hamburg specially for this meeting, an example of international generosity to be the more esteemed because the German Antarctic expedition, which he has done so much to promote, is at last on the verge of taking definite shape. The Italian Ambassador also represented by his presence the friendly interest of a country which in 1880 made a courageous attempt, under Lieut. Bove, to take an active part in south polar work. Invitations to many of the younger scientific men engaged in departments of research bearing on the subject of the meeting had been sent out by the Society, and these were taken advantage of to the full. The interest of some who could not be present was conveyed by letter; a communication from the Duke of Argyll was read by the Secretary, dwelling on the value of the proposed expedition. Lord Kelvin had the evening before, while presiding at a lecture by Dr. Nansen in Glasgow, expressed his own views very strongly. Stating that the lecturer was leaving immediately after the lecture to attend the Royal Society meeting, he said, as reported in the *Glasgow Herald*: "The object of that meeting was to consider a proposal for an expedition to investigate the Antarctic polar regions, and Dr. Nansen was going to help the Society in its deliberations. If such an expedition were undertaken, and he hoped it would, it ought to receive the help of the Government. The British Government should make one of its primary objects the work of exploration, so that there should be nothing unknown of the whole ocean coast-line."

Dr. John Murray introduced the discussion by touching on all the scientific desiderata of the Antarctic regions; and after him nine speakers enforced and extended his arguments. Sir John Evans wisely decided that the discussion should be confined to the purely scientific aspect of the case, and the speakers closely followed his advice. The audience received the various addresses with applause such as is seldom heard in Burlington House. A good deal was made of the extent of our present knowledge, and an outsider might suppose that there was less diversity of opinion than really exists. The different estimates of the value of an Antarctic expedition to zoology, expressed by Dr. Sclater and Prof. D'Arcy Thompson, and the emphatic statement of the discrepancy between Ferrel's (or rather Dr. James Thomson's) theory of atmospheric circulation, and the indications of meteorological observations in the Far South, by Dr. Buchan, were stimulating and suggestive. How little we know of the Antarctic may be gauged from the map accompanying this article.

The meeting, the Chairman observed in closing it, was of unprecedented length, and a number of gentlemen who were prepared to take part had no opportunity to speak; while some of the speeches, especially that of Sir W. J. L. Wharton, in which he spoke of the popularity of such an expedition in the Navy, had to be cut very short. It would be worth while to consider whether some further opportunity might be given to bring before the scientific public the unheard arguments of last week.

The historical argument was not brought forward; but it is of importance in relation to the motive for exploration. At first the Antarctic question was the purely academic one of the possible existence of Antipodes, and was discussed by the ancient Greek geographers from analogy alone. On the revival of exploration in the fifteenth century, the existence of an Antarctic continent shutting in the Indian Ocean to the south, as supposed by Ptolemy, was a matter of much practical concern, for it affected the possibility of a sea-route to India. After the discovery that Africa could be rounded on the south, the appearance of the continent of America was looked on as a sign of the existence of a mass of Antarctic land. When Magellan penetrated his straits, and even after the rounding of Cape Horn, a vast Antarctic continent reaching to the tropics was a matter of common belief. Cook's first voyage of exploration detached New Zealand from this hypothetical continent; his second proved that any continent which might exist lay within the Antarctic circle. With this discovery the political motive for Antarctic exploration vanished. The only possible reason for adequate exploration was thenceforward scientific, and sixty-four years after Cook returned the ships of Sir James Clarke Ross set out on their great cruise. That was fifty-nine years ago. The intervals of sixty-four and fifty-nine years were both marked by the incidental work of other expeditions, such as the circumnavigations of Bellingshausen and Dumont d'Urville, and that of the *Challenger*. Commercial enterprise also sent out a number of daring sailors, the fleets of the Enderbys before Ross, and those of the Scottish and Norwegian whalers since. The commercial motive has proved insufficient in the south, potent as it was for many centuries in the north. The fact stands to-day that if the scientific motive fails to produce the result, the Antarctic regions will never be explored.

Putting the matter in its simplest form, civilised man must understand his dwelling-place; the key to many puzzles, the end of many controversies affecting the theory of the phenomena of the whole world, lies behind the vast Antarctic veil. It is the duty of the human race to lift that veil, whether there be much or little behind it, and the British people, as represented by the Government, ought to take the lead. We ought to take the lead because our territory in Australasia, Africa, and the Falkland Islands comes nearest to the unknown region; because our national welfare is more concerned than any other in the intelligent and safe navigation of the Southern Ocean; and because our Government, our Navy, and our scientific societies are richer and stronger now than they were in the days of Cook and of Ross, both absolutely and with reference to other nations. That other nations are preparing, or have prepared, to take part in wiping off this huge reproach on the enterprise and the self-respect of nineteenth

century man should surely be an inducement to action rather than a deterrent. The value of simultaneous expeditions working in friendly rivalry is in such a case far greater than that of consecutive or isolated work.

HUGH ROBERT MILL.

ERNST CHRISTIAN JULIUS SCHERING.

ON November 2, 1897, as already announced in NATURE, Göttingen lost, at the age of sixty-four, its senior mathematical professor, Ernst Christian Julius Schering, best known as the editor of Gauss's works.

Prof. Schering's life presents one curious feature, rare in the German academic world. Göttingen was the only University with which as student, teacher, or professor he had any connection. The forty-five years of his life there go back to the days when Gauss, Wilhelm Weber and Dirichlet still lived and taught. Although the first of these was to exercise paramount mastery over Schering's future, we can trace the influence of each in his life and writings. Schering's published work deals entirely with subjects in which his celebrated teachers were pioneers—theory of numbers, non-Euclidian geometry, hydrodynamics, electricity and magnetism. As far as one can judge, Schering's personal predilections were for a strictly analytical treatment of pure mathematics; the force of circumstances, however, directed part of his energies to applied mathematics and practical physics. He is said to have shown great mathematical promise at school at Lueneborg and at the Polytechnikum at Hanover; so much so that he abandoned his intention of becoming an architect, and went up to the University in 1852. His studies were crowned with success, and he received prizes both for his Doctor's dissertation, "On the mathematical theory of electric currents," and for his Habilitationsschrift, "On the conformal representation of the ellipsoid on the plane."

In 1860 he became Professor, and was at first engaged in astronomical calculations under Prof. Klinkerfues. In 1863 he embarked on his life-work, the editing of Gauss's papers. Gauss left, besides a large quantity of published work, a mass of notes and of half-finished productions. The work of collecting the published papers, and of looking through, arranging and collecting the unpublished, fell to Schering. From 1863 to 1874 he edited six volumes of collected works, published by the Gesellschaft der Wissenschaft, of Göttingen. He subsequently edited the *Theoria Motus* for the owner of the copyright; this volume, though apparently uniform with the others, does not properly belong to the set, and, the copyright having now expired, the Gesellschaft propose to publish the *Theoria Motus*, together with some still unpublished writings, in a seventh volume of their edition.

It is difficult for any one who has not seen the documents to estimate the labour required to bring them into a form fit for publication. There still remains an enormous mass of unpublished matter, notes on scraps of paper and backs of envelopes, calculations without explanations, statements without proofs, and so on. Until a lingering illness rendered him unfit for much exertion, Schering went on working to bring order into this chaos; but he was unwilling to publish except in a perfected form. Since 1874 no volume had appeared, and, except Prof. Schur, no one had access to any of the original manuscripts.

There was consequently great curiosity about the MSS. when, on Prof. Schering's death, they were brought out and examined. A number of mathematicians have been enlisted by Prof. Klein, and it is hoped that at least the notes on planetary disturbances and the correspondence on non-Euclidian geometry will soon be published. Work that is too imperfect for publication will in future be always accessible at the University library.

Apart from those already mentioned, Schering published numerous papers, mostly to be found between 1870 and 1887, in the Göttingen *Nachrichten* and *Anzeiger* and the *Comptes rendus*. His lectures, which for some years he had done little more than announce, were usually on higher pure mathematics.

In 1868 he became director of the Gauss Magnetic Observatory. His work consisted partly in directing the studies of students in magnetism and kindred subjects, partly in conducting observations, &c. Generally he continued and extended the work as Gauss had planned it. Accounts of his observations, and of various improvements made by him in the instruments, will be found in papers by himself and his brother, Prof. Karl Schering, of Darmstadt.

W. H. AND G. CHISHOLM YOUNG.

NOTES.

ON Saturday last, at the Trocadero Restaurant, a dinner was given to Prof. T. McKenny Hughes by his old students, on the occasion of the twenty-fifth anniversary of his election to the Woodwardian Professorship of Geology at Cambridge. Sir Archibald Geikie presided, and covers were laid for old students and friends to the number of sixty-five. An illuminated address was presented to Prof. Hughes by Dr. R. D. Roberts and Mr A. Strahan as the oldest and earliest of his Cambridge students in the company; and the healths of Prof. and Mrs. Hughes were proposed by Sir A. Geikie. In the course of his speech, Sir A. Geikie alluded to the great and continued growth and success of the Cambridge Geological School, which he characterised as second to none in the world. Prof. Hughes replied, and subsequently the President of the Geological Society (Mr. Whitaker), Sir Henry Howorth, M.P., Prof. James Stuart, M.P., and Dr. Hicks spoke and testified to the value of Prof. Hughes's professional work, and to the wide extent of his personal influence. In addition to those above mentioned, there were present Prof. Wiltshire, Mr. W. Hudleston, Prof. Etheridge, Dr. Henry Woodward, Prof. Lapworth, Prof. Watts, Prof. Ainsworth Davis, Messrs. Teall, Herries, Bauerman, Marr, Harker, Seward, Woods, Reed, Rudler, Kynaston, Mond, and several ladies, many of whom had studied under Prof. Hughes at Cambridge. Letters and telegrams of congratulation from leading Continental geologists were read by Sir A. Geikie. A magnificent silver loving-cup was presented to Prof. McKenny Hughes on Monday, February 28, by his past and present students at Cambridge as a permanent memento of his twenty-five years' work as Woodwardian Professor of Geology, and as a mark of their esteem and gratitude. The cup bore a suitable inscription in Latin, and the arms of the University and of Trinity and Clare Colleges; and an illuminated list of the subscribers was presented with it. Mr. Cowper Reed, Miss Blanche Smith, Dr. Roberts, Prof. Ainsworth Davis, and Rev. W. L. Carter made appropriate speeches, and Prof. Hughes replied.

THE Physico-Mathematical Society of Kazan has made its first award of the Lobachévski Prize to Prof. Sophus Lie, of the University of Leipzig, in consideration of the third volume of his work, "Theorie der Transformationsgruppen." The prize, which is of the value of 500 roubles, is to be adjudged every three years for work in geometry, preferably non-Euclidean geometry, and all works published in Russian, English, French, German, Italian, or Latin in the six years preceding the award are eligible. In Prof. Lie's treatise the theory of non-Euclidean geometry has been exhaustively re-stated and re-established in a profound investigation on the space-problem, based on the work of the late von Helmholtz.

IT is announced in the *Times* that the Local Government Board has given orders that the new form of vaccine mixed with glycerine, described in last week's NATURE (p. 391), is to be served out to all vaccination officers, following upon the recommendation of the Special Commission on Vaccination, which recently examined all the great vaccination departments of foreign Governments. This is to be undertaken at once, without regard to the vaccination legislation promised in the Queen's Speech, and will be completely independent of such a measure. Some delay has arisen in sending out the new lymph, owing to the want of a special laboratory for the cultivation of the matter; but this will not now be long delayed, as soon as the Local Government Medical Board is granted funds to purchase or secure a laboratory.

M. DE FONVIELLE informs us that the President of the International Commission for the exploration of the high atmosphere has issued a circular notifying that a conference will be held at Strassburg on March 28, to discuss the results obtained up to this time by the ascent of free balloons to high altitudes, and determining the measures which are to be taken to collect registered observations. The German kite-balloons and American meteorological kites will also be subject for discussion. Invitations have been sent to a number of men of science who are working in similar fields of inquiry. The remarks and discussions will be carried on in three languages—English, French, and German.

ON Saturday last, February 26, the Council of the Society of Arts attended at Marlborough House, when the Prince of Wales, President of the Society, presented the Albert Medal to Mr. G. J. Symons, F.R.S., "for the services he has rendered to the United Kingdom by affording to engineers engaged in the water supply and the sewage of towns a trustworthy basis for their work, by establishing and carrying on during nearly forty years systematic observations (now at over 3000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself."

THE lists of prize competitions for 1898 and 1899 have just reached us from the Belgian Academy. The international competitions consist in the answering of six questions, for each of which a prize of 600 francs is offered. These questions are the following: (1) Describe the researches already made on critical phenomena in physical science, and complete them by new researches. (2) Expound and criticise the various theories of the constitution of solutions, and supplement them by new researches, especially with regard to the existence of hydrates in aqueous solution. (3) Make some important contribution to the theory of correspondences (*Verwandtschaften*) between two spaces. (4) Original research on digestion in carnivorous plants. (5) Original research on the structure and development of a Platode, with the object of determining whether there are any phylogenic relations between Platyhelms and Enterocœlians. (6) Do the Schizophytes possess a nucleus? If so, what is its structure and its mode of division? In addition, a prize of 800 francs is offered for a solution of the problem of determining the influence exercised by the nitryl radicle NO_2 in aliphatic compounds on the characteristics or functions appertaining to alcohol, haloid ether, oxy-ether, &c. All papers must be written in French or Flemish, and must be sent to M. le Secrétaire perpetuel, au Palais des Académies, Bruxelles, before August 1, 1898. They must bear a motto (not a pseudonym), and must be accompanied by a sealed envelope bearing the same motto outside, and the competitor's name and address inside. Special correctness is required in the matter of quotations. The conditions for 1899 are similar. The questions relate to the thermal conductivity of liquids and solutions, to straight-line geometry, to the variation of latitude, to albuminoid substances in nutrition, to the Apterygota, and to the Upper Eocene period.

THE Rome correspondent of the *Daily Mail* announces that King Humbert has given his permission to his young nephew, the Duke of the Abruzzi, to undertake an expedition in the Arctic regions. The Prince intends to visit Greenland and Lapland, and to study the sea currents and the geology of the locality. He will be accompanied by an aide-de-camp, by Drs. Gonella and Defilippi, who were his companions in the expedition to Alaska, and by a few young naval officers. According to a Reuter telegram from Christiania, the Duke will leave next summer for Spitsbergen in order to explore the country, but the expedition will not start until 1899, and its first objective will be Franz Josef Land. Should the conditions of the ice be favourable, depôts will be established, and an attempt will be made to reach the Pole by means of sledges and dogs. In the event of this proving impracticable, the expedition will confine itself to an exploration of Franz Josef Land. On the advice of Captain Sverdrup, the Duke will ask the Danish Government for a supply of dogs from Greenland, as these are considered to be the best.

THE brilliant lantern slides exhibited by Dr. Isaac Roberts at the Royal Societies' Club on Wednesday, February 23, in illustration of his lecture on "Recent Intelligence from Regions in the Stellar Universe," constituted a striking testimony to his achievements in astronomical photography. The nebulæ and clusters of stars which Dr. Roberts has now photographed number about five hundred, and a list of them, as they are taken each year, is published in his annual Observatory Report in the *Monthly Notices* of the Royal Astronomical Society. It is not too much to say that these photographs contain a mine of new astronomical information which has not yet been worked, and the value of which will increase with years. The pictures represent celestial species awaiting the mind of a Darwin to coordinate them; for they show stellar systems in the various stages of growth from the embryonic nebula to the finished star. Dr. Roberts has himself endeavoured to discover the scheme of stellar evolution as revealed by his photographs, and he placed the results before his audience last week. His method of doing this was soundly scientific. To begin with, he showed a number of photographs of star regions in which the stars could be seen grouped into semicircles, segments, portions of ellipses, and lines of various degrees of curvature. Some of these groups were composed of bright stars of nearly equal magnitude; some of faint stars, also of nearly equal magnitude; while the distances between the stars in the various groups were remarkably regular. Passing from these characteristics of stellar arrangement to photographs of spiral nebulæ, Dr. Roberts pointed out that the nebulous matter in the spirals was broken up into star-like loci, which in the regularity of their distribution resembled the curves and combinations of stars exhibited by photographs upon which no trace of nebulosity was visible. It thus seemed that the curvilinear grouping of stars of nearly equal magnitude gave evidence that the stars had been evolved out of some attenuated material in space by the action of vortical motions and by gravitation. Exactly how the vortical motions were caused, or what has brought about the distributions of nebulosity in the spiral nebulæ, cannot be answered; but the marvellous pictures exhibited by Dr. Roberts establish the reality of the grouping, and furnish students of celestial mechanics with rich food for contemplation.

THE Bishop of London, one of its Vice-Presidents, has consented to preside at the annual general meeting of Governors of the Dental Hospital of London, to be held at the Hospital, Leicester Square, on Thursday, March 17, at 5.30 p.m.

A correspondent writes to inform us, with respect to the Lincolnshire Naturalists' Union, that the papers written by members of that association are published in the *Naturalist*, which is issued under the auspices of the Yorkshire Naturalists' Union. While desirous in every way to further the interests of local societies, the demands upon our space render it impossible for us to enter into local controversies, and we must decline to notice any further communications relating to this division among the naturalists of Lincolnshire.

The following are the arrangements for lectures during March at the Imperial Institute. These lectures will be open free to the public, without tickets, seats being reserved for Fellows of the Imperial Institute and persons introduced by them. Monday, March 7, at 8.30, "The Mineral and other Resources of Newfoundland," by Mr. J. H. Collins; Wednesday, March 9, at 3, "A Demonstration with the Cinematograph of 'Harvesting in Manitoba in 1897,'" by Mr. J. S. Freer; Thursday, March 10, at 8.30, "Colonisation in Canada," by the Marquis Bouthillier-Chavigny; Monday, March 14, at 8.30, "The Alps of New Zealand," by Mr. E. A. Fitzgerald; Monday, March 21, at 8.30, "Siam—Present and Future," by Mr. Frederick W. Verney; Monday, March 28, at 8.30, "On a proposed Railway Connection between India and Ceylon," by Mr. John Ferguson.

From a preliminary note in the *Atti dei Lincei*, we learn that Dr. B. Longo, by studying the embryology of the *Calycanthaceæ*, has discovered in their ovules certain characteristics forming a new link between this order of plants and the *Rosaceæ*.

We are glad to see that an attempt is being made to increase the usefulness of the collections of abstracts which, under the editorship of Mr. J. Swinburne, have for several years constituted the second half of the *Proceedings* of the Physical Society of London. With the title "Science Abstracts, Physics and Electrical Engineering," these records of current research have now, for the first time, appeared in separate form, and the Institution of Electrical Engineers has now co-operated with the Physical Society in their publication. Mr. Swinburne still holds the post of editor, and Mr. W. R. Cooper has been appointed sub-editor. The change is calculated both to extend the circulation and enlarge the scope of these abstracts by introducing matter of a practical nature without detracting from the value of the notices of the more theoretical papers. The numbers may be obtained by non-members from the publishers, Messrs. Taylor and Francis.

In a communication to the *Philosophical Magazine* for February, on the failure of german-silver and platinoid wires used for resistance coils in tropical climates, Mr. Rollo Appleyard remarks:—"Can metallurgists tell us the difference in constitution and structure between a german-silver wire that decays in four weeks and another that, under similar circumstances, never fails? Or, what is even more important, can they make us platinoid that shall never fail? If they cannot, it becomes necessary to surrender these cheaper and better electrical materials, and fall back upon the more expensive alloys, beginning at platinum-silver. If sufficient time and means were at the disposal of metallurgists, they might discover the secret of permanence in alloys. Germany, with the advantages of a National Laboratory, has already attacked the question, and "manganin" is the result. Its adoption there as a satisfactory alloy is directly due to work done at the Reichsanstalt. But it has yet to be proved that manganin will endure the conditions imposed by the tropics. Moreover, the doubt arises as to whether it is desirable to obtain from abroad material that ought to be produced in our own country. British cable manufacturers are already importing thousands of tons of sheathing wire from Germany; and it seems probable that, for the want of a National Laboratory, instrument-makers will now get their resistance-wire from that same adventurous foreign source."

The Report of the Meteorological Council for the year ending March 31, 1897, has recently been presented to Parliament. The Office continues to collect data relating to the meteorology of the ocean, and supplies complete outfits of meteorological instruments to officers of merchant ships who are willing to make observations. Her Majesty's ships are also supplied with instruments, and valuable observations are received from officers of the Royal Navy. We have previously noticed the monthly current charts which have been published for several oceans. A work on the meteorology of the Southern Ocean, between the Cape of Good Hope and New Zealand, is in course of preparation; and as no charts for this area have been previously published by the Office, the work will probably be of much value. The results of the weather forecasts continue to show a considerable amount of success; for those published in the morning newspapers a complete or partial succsss of 81 per cent. is claimed for the year in question, while for the special forecasts issued during the hay-harvest, the figures show that 88 per cent. were useful. A still greater success is claimed for the warnings of storms, no less than 91·5 per cent. being justified. For the study of the climatology of the British Isles, the Office continues to subsidise, and to maintain an intimate relationship with, a small number of observatories of the highest class, and to supplement this information by observations from a large number of voluntary stations. The principal miscellaneous investigations during the year refer to anemometer experiments, earth temperatures, and the recently published rainfall statistics for the British Islands.

Under the name of "alinit" a new manure suitable for all kinds of grain has been recently introduced to the scientific and agricultural worlds by that enterprising firm of colour manufacturers, Friedrich Bayer and Co., whose name is already so indissolubly associated with nitragin, and the production of diphtheria anti-toxins. The discoverer of this mysterious material is a certain Herr Caron, of Ellenbach; and alinit in its present form is the outcome of four years' laborious experimental investigations on the bacterial flora of different soils, resulting in the isolation of a particular bacillus, upon the presence of which would appear to depend to an important extent the fertility of certain soils. Caron has already obtained striking results on an experimental scale with crops from soil treated with pure cultures of this bacillus—*Ellenbachensis alpha*, as he has called it. Alinit is to be had commercially from the above firm, and is sent out as a creamy-yellow powder, of which the nitrogenous constituents have been ascertained to be 2·5 per cent. Its closer investigation has been made the subject of memoirs by Stoklasa, of Prague, and also Messrs. Stutzer and Hartleb. The bacillus is contained in this powder in the form of spores, and on cultivation is found to belong to the well-known aërobic group of bacteria known as the hay bacilli, resembling very closely the bacillus mycoides so frequently found in soil, and the bacillus *Megatherium*. It appears to grow easily upon all the usual culture media. Before its precise place amongst bacterial fertilisers can be determined, many more elaborate and carefully-conducted experiments must be carried out.

Prof. Arnaldo Faustini contributes to the *Bollettino* of the Italian Geographical Society, which, by the way, appears in a new ornamental cover, a note on the "Appearances of Land" recorded by various voyagers in the Antarctic regions. The paper gives point to some of the strongest arguments for Antarctic research, and summarises the topographical uncertainties which future expeditions must set themselves to clear up.

AT the meeting of the Vienna Academy of Sciences, on December 16 last, letters were read from Dr. Steindachner, the Director of the *Pola* Expedition in the Red Sea. Writing at the end of November, Dr. Steindachner reports that deep-sea work was at an end, but that observations along the coast and amongst the islands were being continued as the very unfavourable weather permitted. Valuable collections were made on the Dahalak and Nakra Khor islands, specially in connection with the coral formations and the shallow-water fishes; and the extinct volcanoes and the lava-sheets of Peacock Hill Bay were examined. The *Pola* reached Assab on November 30, and Mocha on December 14, 1897.

M. LE COMTE P. DE BARTHELEMY publishes a letter in the *Comptes rendus* of the Paris Geographical Society, on the possible lines of communication between Luang-Prabang and the coast, and on the navigability of the Mekong. It would seem that little or nothing can be made of the Tran-Nunh plains as long as they remain in the hands of the present degenerate population; although something might be possible if the Meo population of the mountainous districts took their place. The only part of the Mekong really adapted to navigation is the stretch of 650 kilometres between Vien-Tiane and Savannakhek. The future of Luang-Prabang evidently depends on the speedy realisation of one or more of the numerous railway schemes proposed.

MR. PORTER has just published the tenth part of Messrs. Sclater and Thomas's illustrated "Book of Antelopes." Two more parts, already in a forward state, will finish the account of the Gazelles and allied forms, and bring the third volume to a close. The fourth and concluding volume will be devoted to the Oryxes and Strepsiceres. Altogether the work will contain one hundred coloured plates, about seventy of which were originally prepared under the superintendence of the late Sir Victor Brooke, many years ago, for a somewhat similar work which he had planned, but did not live to accomplish.

IN referring to the election of three new members of the Athenæum Club, in the first note last week, the designation of the Club was inadvertently omitted.

DR. G. LINDSAY JOHNSON writes calling attention to an obvious misprint in the fortieth stereotyped edition of Vega's Logarithmic Tables. The logarithmic sine of 0° 6′, printed as 9·2418771, should be 7·2418771.

PROF. CHARLES FABRE, of the University of Toulouse, has just completed the second supplement to his well-known treatise on Photography. The new volume deals with the progress made in all branches of the subject during the years 1893 to 1896.

THE additions to the Zoological Society's Gardens during the past week include three Black-backed Jackals (*Canis mesomelas*) from South Africa, presented by Mr. J. E. Matcham; a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Captain Travers; two Black Spider-Monkeys (*Ateles ater*) from Eastern Peru, a Downy Owl (*Pulsatrix torquata*) from Pará, twelve White's Tree Frogs (*Hyla cærulea*) from Australia, deposited; a Temminck's Tragopan (*Ceriornis temmincki*) from China, a Bearded Lizard (*Amphibolurus barbatus*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

ECLIPSE NEGATIVES.—In order to minimise the risk in returning the eclipse negatives to England from the Eclipse Station at Viziadrug, they were divided into three batches, a complete set being made up in each batch by positives from the other negatives. Two of these sets have already arrived safely in England, and they testify to the clearness of the atmosphere during totality. The smallness of the prominences is very noticeable, both in hydrogen and K (calcium) radiations, a fact which was observed at South Kensington in H_α light on the day of the eclipse. Another conspicuous feature is the intense brightness of some of the coronal streamers at their base. The negatives of the corona also verify the reports from the visual observations, which stated that the general form was like those of 1886 and 1896. The resemblance to the latter is very striking, especially when we remember that it was the north point of the axis which was presented to us at that eclipse; whilst in the last eclipse in January, the south point of the axis is inclined towards us.

CINEMATOGRAPH IN ASTRONOMY.—We have already learnt that the cinematograph was employed with success during the recent solar eclipse, but M. Camille Flammarion has turned it to the further use of exhibiting to a large audience the various celestial movements. He has photographed the heavens at different times from sunset to sunrise with a wide-angled lens in the cinematograph, and as the whole movements during a single night are projected on the screen, and passed through in a few minutes, no very rapid rate of exposing the photographs is required. For showing sunset at one horizon, followed by the movement of the stars and sunrise at the other horizon, and also the movement of the moon amongst the stars, this method has been employed with great success. He proposes in addition to this to photograph the sun-spots, and thus exhibit by their movement the rotation of the sun. For the earth he has constructed a large model, and photographed it with a cinematograph when rotating and illuminated by light arranged so as to represent the sun; this was exhibited at the last meeting of the French Astronomical Society, and was greatly admired.

A PROBABLE NEW STAR.—In *Astr. Nach.*, No. 3476, it is pointed out that the probable new star announced by Espin, and not in the B.D., is, however, in the small edition as an addendum, +32°·1526*a*; 8·0 mag., 7h. 12m. 15·6s., +32° 18′·4 L. This is the same star as recorded by the Rev. T. E. Espin, so in all probability it is another observation of a variable star. An examination of its spectrum, made at South Kensington, at once showed that the star had not a spectrum peculiar to temporary stars, and hence was probably only an omission from the star charts.

ELECTROLYTIC REFLECTORS.—In a paper read before the Institution of Electrical Engineers, and reproduced in *Industries and Iron* for February 18, Mr. Sherard Cowper-Coles describes a method by which a metallic reflector can be made by an electrolytic process. The method is intended, in the first place, for the manufacture of metallic mirrors for use as projectors in search lights, and also to overcome the difficulty that has been experienced in producing a true metallic reflector that will not readily tarnish when exposed to the heat of an arc light; but the same method is also applicable for the production of mirrors for astronomical purposes. The process is, of course, a copying one, and consists in taking a concave surface from a convex mould, so figured as to give the correct curvature to the copy taken from it. In the words of the author, "a glass mould is prepared, the convex side of which is accurately shaped and polished to form a true reflecting surface. On the prepared surface is deposited a coating of metallic silver, which is thrown down chemically on the glass, and then polished so as to ensure the copper backing being adherent to the silver. The mould thus prepared is placed in a suitable ring and frame, and immersed in an electrolyte of copper sulphate, the mould being rotated in a horizontal position. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and then gradually raising the temperature of the water to 120° F., when the metal reflector will leave the glass mould, due to the unequal expansion of the two." The concave surface of the reflector thus obtained has a brilliant polish, and requires no further treatment to answer all the purposes of a reflector; but for uses where tarnishing would soon take place, it is further immersed in a bath of palladium ammonium chloride, and a coating of palladium deposited on the concave side; this metal does not tarnish readily, and resists heat to a wonderful degree.

This new method of making mirrors electrolytically would seem to have a promising future before it, for great pains could be taken in making the mould, from which any number of copies could be taken without the usual laborious process of grinding and figuring each individual mirror, and yet each one would have a correct reflecting surface.

SCIENTIFIC ADVANTAGES OF AN ANTARCTIC EXPEDITION.[1]

DR. MURRAY'S ADDRESS.

FROM a scientific point of view the advantages to be derived from a well-equipped and well-directed expedition to the Antarctic would, at the present time, be manifold. Every department of natural knowledge would be enriched by systematic observations as to the order in which phenomena coexist and follow each other, in regions of the earth's surface about which we know very little or are wholly ignorant. It is one of the great objects of science to collect observations of the kind here indicated, and it may be safely said that without them we can never arrive at a right understanding of the phenomena by which we are surrounded, even in the habitable parts of the globe.

Before considering the various orders of phenomena, concerning which fuller information is urgently desired, it may be well to point out a fundamental topographical difference between the Arctic and Antarctic. In the northern hemisphere there is a polar sea almost completely surrounded by continental land, and continental conditions for the most part prevail. In the southern hemisphere, on the other hand, there is almost certainly a continent at the South Pole, which is completely surrounded by the ocean, and, in those latitudes, the most simple and extended oceanic conditions on the surface of the globe are encountered.

The Atmosphere.

One of the most remarkable features in the meteorology of the globe is the low atmospheric pressure at all seasons in the southern hemisphere south of latitude 45° S., with the accompanying strong westerly and north-westerly winds, large rain and snow fall, all round the South Polar regions. The mean pressure seems to be less than 29 inches, which is much lower than in similar latitudes in the northern hemisphere. Some meteorologists hold that this vast cyclonic system and low-pressure area continues south as far as the pole, the more southerly parts being traversed by secondary cyclones. There are, however, many indications that the extreme South Polar area is occupied by a vast anticyclone, out of which winds blow towards the girdle of low pressure outside the ice-bound region. In support of this view it is pointed out that Ross's barometric observations indicate a gradual rise in the pressure south of the latitude of 75° S., and all Antarctic voyagers agree that when near the ice the majority of the winds are from the south and south-east, and bring clear weather with fall of temperature, while northerly winds bring thick fogs with rise of temperature.

All our knowledge of the meteorological conditions of the Antarctic is limited to a few observations during the midsummer months, and these indicate that the temperature of the snow-covered Antarctic continent is even at that time much lower than that of the surrounding sea. The anticyclonic area at the South Pole appears therefore to be permanent, and when in winter the sea-ice is for the most part continuous and extends far to the north, the anticyclonic area has most probably a much wider extension than in summer. This is indicated by the south-easterly winds, which at times blow towards the southern point of the American continent in June and July.

All observations in high southern latitudes indicate an extremely low summer temperature. In winter we have no direct observations. The mean of Ross's air temperatures south of latitude 63° S. was 28·74° F., which is about the freezing-point of sea-water, and his maximum temperature was 43·5° F. Both Wilkes and D'Urville observed pools of fresh water on several icebergs, and, when sailing along the ice barrier, Ross saw "gigantic icicles depending from every projecting point of its perpendicular cliffs" (Ross, "Antarctic Voyage," vol. i. p. 237), so it is probable that extensive melting sometimes takes place.

In the latitude of the Antarctic circle the air is frequently at or near the point of saturation, and precipitation takes place in the form of rain, sleet, snow, or hail. Most of the observations near the ice-covered land show, however, a much drier atmosphere, and in all probability precipitation over the Antarctic continent takes place in the form of fine snow crystals, such as is recorded in the interior of Greenland.

There would appear, then, to be good reasons for believing that the region of the South Pole is covered by what may be regarded practically as a great permanent anticyclone, with a much wider extension in winter than in summer. It is most likely that the prevailing winds blow out from the pole all the year round towards the surrounding sea, as in the case of Greenland; but, unlike Greenland, this area is probably seldom traversed by cyclonic disturbances.

But what has been stated only shows how little real knowledge we possess concerning the atmospheric conditions of high southern latitudes. It is certain, however, that even two years' systematic observations within these regions would be of the utmost value for the future of meteorological science.

Antarctic Ice.

From many points of view it would be important to learn something about the condition and distribution of Antarctic sea-ice during the winter months, and especially about the position and movements of the huge table-shaped icebergs at this and other seasons of the year. These flat-topped icebergs, with a thickness of 1200 or 1500 feet, with their stratification and their perpendicular cliffs, which rise 150 or 200 feet above and sink 1100 or 1400 feet below the level of the sea, form the most striking peculiarity of the Antarctic Ocean. Their form and structure seem clearly to indicate that they were formed on an extended land surface, and have been pushed out over low-lying coasts into the sea.

Ross sailed for 300 miles along the face of a great ice-barrier from 150 to 200 feet in height, off which he obtained depths of 1800 and 2400 feet. This was evidently the sea-front of a great creeping glacier or ice-cap just then in the condition to give birth to the table-shaped icebergs, miles in length, which have been described by every Antarctic voyager.

All Antarctic land is not, however, surrounded by such inaccessible cliffs of ice, for along the seaward faces of the great mountain ranges of Victoria Land the ice and snow which descend to the sea apparently form cliffs not higher than 10 to 20 feet, and in 1895 Kristensen and Borchgrevink landed on a pebbly beach, occupied by a penguin rookery, at Cape Adare without encountering any land-ice descending to the sea. Where a penguin rookery is situated, we may be quite sure that there is occasionally open water for a considerable portion of the year, and that consequently landing might be effected without much difficulty or delay, and further that a party, once landed, might with safety winter at such a spot, where the penguins would furnish an abundant supply of food and fuel. A properly equipped party of observers situated at a point like this on the Antarctic continent for one or two winters might carry out a most valuable series of scientific observations, make sucessful excursions towards the interior, and bring back valuable information as to the probable thickness of the ice-cap, its temperature at different levels, its rate of accumulation, and its motions, concerning all which points there is much difference of opinion among scientific men.

Antarctic Land.

Is there an Antarctic continent? It has already been stated that the form and structure of the Antarctic icebergs indicate that they were built up on, and had flowed over, an extended land surface. As these bergs are floated to the north and broken up in warmer latitudes they distribute over the floor of the ocean a large quantity of glaciated rock fragments and land detritus. These materials were dredged up by the *Challenger* in considerable quantity, and they show that the rocks over which the Antarctic land-ice moved were gneisses, granites, mica-schists, quartziferous diorites, grained quartzites, sandstones, limestones, and shales. These lithological types are distinctively indicative of continental land, and there can be no doubt about their having been transported from land situated towards the South Pole. D'Urville describes rocky islets off Adélie Land composed of granite and gneiss. Wilkes found on an iceberg, near the same place, boulders of red sandstone and basalt. Borchgrevink and Bull have brought back fragments of mica-schists and other continental rocks from Cape Adare. Dr. Donald brought back from Joinville Island a piece of red jasper or chert containing Radiolaria and Sponge spicules. Captain Larsen brought from Seymour Island pieces of fossil coniferous wood, and also fossil shells of *Cucullæa*, *Cytherea*, *Cyprina*, *Teredo*, and *Natica*, having a close resemblance to species known to occur in lower Tertiary beds in Britain and Patagonia. These fossil remains indicate in these areas a much warmer climate in past times. We are thus in possession of abundant indications that there is a wide extent of continental land within the ice-bound regions of the southern hemisphere.

[1] Address by Dr. John Murray, F.R.S., and subsequent speeches, delivered at a special meeting of the Royal Society on February 24.

It is not likely that any living land-fauna will be discovered on the Antarctic continent away from the penguin rookeries. Still, an Antarctic expedition will certainly throw much light on many geological problems. Fossil finds in high latitudes are always of special importance. The pieces of fossil wood from Seymour Island can hardly be the only relics of plant life that are likely to be met with in Tertiary and even older systems within the Antarctic. Tertiary, Mesozoic, and Palæozoic forms are tolerably well developed in the Arctic regions, and the occurrence of like forms in the Antarctic regions might be expected to suggest much as to former geographical changes, such as the extension of the Antarctic continent towards the north, and its connection with, or isolation from, the northern continents, and also as to former climatic changes, such as the presence in pre-Tertiary times of a nearly uniform temperature in the waters of the ocean all over the surface of the globe.

Magnetic and Pendulum Observations, Geodetic Measurements, Tides and Currents.

In any Antarctic expedition magnetic observations would, of course, form an essential part of the work to be undertaken, and the importance of such observations has been frequently dwelt upon by eminent physicists and navigators. Should a party of competent observers be stationed at Cape Adare for two years, pendulum observations could be carried out there and at other points within the Antarctic, or even on icebergs and on the interior ice-cap. It might be possible to measure a degree on the Antarctic continent or ice-cap, which would be a most useful thing to do. By watching the motions of the icebergs and ice from land at Cape Adare, much would be learnt about oceanic currents, and our knowledge of the tides would be increased by a systematic series of tidal observations on the shores of Antarctica, where we have at present no observations. The series of scientific observations here mentioned, and others that might be indicated, would fill up many gaps in our knowledge of the physical conditions of these high southern latitudes.

Depth of the Antarctic Ocean.

In regard to the depth of the ocean immediately surrounding the Antarctic continent we have at present very meagre information, and one of the objects of an Antarctic expedition would be to supplement our knowledge by an extensive series of soundings in all directions throughout the Antarctic and Southern Oceans. It would in this way be possible, after a careful consideration of the depths and marine deposits, to trace out approximately the outlines of the Antarctic continent. At the present time we know that Ross obtained depths of 100 to 500 fathoms all over the great bank extending to the east of Victoria Land, and somewhat similar depths have been obtained extending for some distance to the east of Joinville Island. Wilkes sounded in depths of 500 and 800 fathoms about twenty or thirty miles off Adélie Land. The depths found by the *Challenger* in the neighbourhood of the Antarctic circle were from 1300 to 1800 fathoms, and further north the *Challenger* soundings ranged from 1260 to 2600 fathoms. To the south-west of South Georgia, Ross paid out 4000 fathoms of line without reaching bottom. In the charts of depth which I have constructed, I have always placed a deep sea in this position; for it appears to me that Ross, who knew very well how to take soundings, was not likely to have been mistaken in work of this kind.

The few indications which we thus possess of the depth of the ocean in this part of the world seem to show that there is a gradual shoaling of the ocean from very deep water towards the Antarctic continent, and, so far as we yet know, either from soundings or temperature observations, there are no basins cut off from general oceanic circulation by barriers or ridges, similar to those found towards the Arctic.

Deposits of the Antarctic Ocean.

The deposits which have been obtained close to the Antarctic continent consist of blue mud, containing glauconite, made up for the most part of detrital matters brought down from the land, but containing a considerable admixture of the remains of pelagic and other organisms. Further to the north there is a very pure diatom ooze, containing a considerable quantity of detrital matter from icebergs, and a few pelagic foraminifera. This deposit appears to form a zone right round the earth in these latitudes. Still further to the north the deposits pass in deep water, either into a Globigerina ooze, or into a red clay with manganese nodules, sharks' teeth, ear-bones of whales, and the other materials characteristic of that deep-sea deposit. Since these views, however, as to the distribution of deep-sea deposits throughout these high southern latitudes, are founded upon relatively few samples, it cannot be doubted that further samples from different depths in the unexplored regions would yield most interesting information.

Temperature of the Antarctic Ocean.

The mean daily temperature of the surface waters of the Antarctic, as recorded by Ross, to the south of latitude 63° S. in the summer months, varies from 27·3° to 33·6°, and the mean of all his observations is 29·85°. As already stated, his mean for the air during the same period is somewhat lower, being 28·74°. In fact, all observations seem to show that the surface water is warmer than the air during the summer months.

The *Challenger* observations of temperature beneath the surface indicate the presence of a stratum of colder water wedged between warmer water at the surface, and warm water at the bottom. This wedge-shaped stratum of cold water extends through about 12° of latitude, the thin end terminating about latitude 53° S., its temperature varying from 28° at the southern thick end to 32·5° at the northern thin end, while the temperature of the overlying water ranges from 29° in the south to 38° in the north, and that of the underlying water from 32° to 35°. This must be regarded as the distribution of temperature only during the summer, for it is improbable that during the winter months there is a warmer surface layer.

In the greater depths of the Antarctic, as far south as the Antarctic circle, the temperature of the water varies between 32° and 35° F., and is not, therefore, very different from the temperature of the deepest bottom water of the tropical regions of the ocean. The presence of this relatively warm water in the deeper parts of the Antarctic Ocean may be explained by a consideration of general oceanic circulation. The warm tropical waters which are driven southwards along the eastern coasts of South America, Africa, and Australia into the great all-encircling Southern Ocean, there become cooled as they are driven to the east by the strong westerly winds. These waters, on account of their high salinity, can suffer much dilution with Antarctic water, and still be denser than water from these higher latitudes at the same temperature. Here the density observations and the sea-water gases indicate that a large part of the cold water found at the greater depths of the ocean probably leaves the surface and sinks towards the bottom in the Southern Ocean, between the latitudes of 45° and 56° S. These deeper, but not necessarily bottom, layers are then drawn slowly northwards towards the tropics, to supply the deficiencies there produced by evaporation and southward-flowing surface currents, and these deeper layers of relatively warm water appear likewise to be slowly drawn southwards to the Antarctic area to supply the place of the ice-cold currents of surface water drifted to the north. This warm underlying water is evidently a potent factor in the melting and destruction of the huge table-topped icebergs of the southern hemisphere. While these views as to circulation of oceanic water appear to be well established, still a fuller examination is most desirable at different seasons of the year, with improved thermometers and sounding machines. Indeed, all deep-sea apparatus has been so much improved as a result of the *Challenger* explorations, that the labour of taking salinity and all other oceanographical observations has been very much lessened.

Pelagic Life of the Antarctic Ocean.

In the surface waters of the Antarctic there is a great abundance of diatoms and other marine algæ. These floating banks or meadows form primarily not only the food of pelagic animals, but also the food of the abundant deep-sea life which covers the floor of the ocean in these south polar regions. Pelagic animals, such as copepods, amphipods, molluscs, and other marine creatures, are also very abundant, although species are fewer than in tropical waters. Some of these animals seem to be nearly, if not quite, identical with those found in high northern latitudes, and they have not been met with in the intervening tropical zones. The numerous species of shelled Pteropods, Foraminifera, Coccoliths, and Rhabdoliths, which exist in the tropical surface waters, gradually disappear as we approach the Antarctic circle, where the shelled Pteropods are represented by a small *Limacina*, and the Foraminifera by only two species of *Globigerina*, which are apparently identical with those in the Arctic Ocean. A peculiarity of the tow-net gatherings made by the *Challenger* Expedition in high southern

latitudes, is the great rarity or absence of the pelagic larvæ of benthonic organisms, and in this respect they agree with similar collections from the cold waters of the Arctic seas. The absence of these larvæ from polar waters may be accounted for by the mode of development of benthonic animals to be referred to presently. It must be remembered that many of these pelagic organisms pass most of their lives in water of a temperature below 32° F., and it would be most interesting to learn more about their reproduction and general life-history.

Benthos Life of the Antarctic Ocean.

At present we have no information as to the shallow-water fauna of the Antarctic continent; but, judging from what we do know of the off-lying Antarctic islands, there are relatively few species in the shallow waters in depths less than 25 fathoms. On the other hand, life in the deeper waters appears to be exceptionally abundant. The total number of species of Metazoa collected by the *Challenger* at Kerguelen in depths less than 50 fathoms was about 130, and the number of additional species known from other sources from the shallow waters of the same island is 112, making altogether 242 species, or 30 species less than the number obtained in eight deep hauls with the trawl and dredge in the Kerguelen region of the Southern Ocean, in depths exceeding 1260 fathoms, in which eight hauls 272 species were obtained. Observations in other regions of the Great Southern Ocean, where there is a low mean annual temperature, also show that the marine fauna around the land in high southern latitudes appears to be very poor in species down to a depth of 25 fathoms, when compared with the number of species present at the mud-line about 100 fathoms, or even at depths of about 2 miles.

In 1841 Sir James Ross stated that the animals he dredged off the Antarctic continent were the same as those he had dredged from similar depths in the Arctic Seas, and he suggested that they might have passed from the one pole to the other by way of the cold waters of the deep sea.[1] Subsequent researches have shown that, as with pelagic organisms, many of the bottom-living species are identical with, or closely allied to, those of the Arctic regions, and are not represented in the intermediate tropical areas. For instance, the most striking character of the shore-fish fauna of the Southern Ocean is the reappearance of types inhabiting the corresponding latitudes of the northern hemisphere, and not found in the intervening tropical zone. This interruption of continuity in the distribution of shore-fishes is exemplified by species as well as genera, and Dr. Günther enumerates eleven species and twenty-nine genera as illustrating this method of distribution. The following are among the species:—Chimæra (*Chimæra monstrosa*), two species of Dog-fish (*Acanthias vulgaris* and *A. Blainvilli*), the Monk-fish (*Rhina squatina*), John Dory (*Zeus faber*), Angler (*Lophius piscatorius*), Bellows-fish (*Centriscus scolopax*), Sprat (*Clupea sprattus*). The genus by which the family Berycidæ is represented in the southern temperate zone (*Trachichthys*) is much more nearly allied to the northern than to the tropical genera. "As in the northern temperate zone, so in the southern . . . the variety of forms is much less than between the tropics. This is especially apparent on comparing the number of species constituting a genus. In this zone, genera composed of more than ten species are the exception, the majority having only from one to five." . . . "*Polyprion* is one of those extraordinary instances in which a very specialised form occurs at almost opposite points of the globe, without having left a trace of its previous existence in, or of its passage through, the intermediate space."

Speaking of the shore-fishes of the Antarctic Ocean, Günther says: "The general character of the fauna of Magelhæn's Straits and Kerguelen's Land is extremely similar to that of Iceland and Greenland. As in the Arctic fauna, Chondropterygians are scarce, and represented by *Acanthias vulgaris* and species of *Raja*. . . . As to Acanthopterygians, Cataphracti, and Scorpænidæ are represented as in the Arctic fauna, two of the genera (*Sebastes* and *Agonus*) being identical. The Cottidæ are replaced by six genera of Trachinidæ, remarkably similar in form to Arctic types. . . . Gadoid fishes reappear, but are less developed; as usual they are accompanied by *Myxine*. The reappearance of so specialised a genus as *Lycodes* is most remarkable."[2]

These statements with reference to shore-fishes might, with some modifications, be repeated concerning the distribution and character of all classes of marine invertebrates in high northern and high southern latitudes. The *Challenger* researches show that nearly 250 species taken in high southern latitudes occur also in the northern hemisphere, but are not recorded from the tropical zone. Fifty-four species of sea-weeds have also been recorded as showing a similar distribution.[1] Bipolarity in the distribution of marine organisms is a fact, however much naturalists may differ as to its extent and the way in which it has originated.

All those animals which secrete large quantities of carbonate of lime greatly predominate in the tropics, such as Corals, Decapod Crustacea, Lamellibranchs, and Gasteropods. On the other hand, those animals in which there is a feeble development of carbonate of lime structures predominate in cold polar waters, such as Hydroida, Holothuroidea, Annelida, Amphipoda, Isopoda, and Tunicata. This difference is in direct relation with the temperature of the water in which these organisms live, carbonate of lime being thrown down much more rapidly and abundantly in warm than in cold water by ammonium carbonate, one of the waste products of organic activity.

In the Southern and Sub-antarctic Ocean a large proportion of the Echinoderms develop their young after a fashion which precludes the possibility of a pelagic larval stage. The young are reared within or upon the body of the parent, and have a kind of commensal connection with her till they are large enough to take care of themselves. A similar method of direct development has been observed in eight or nine species of Echinoderms from the cold waters of the northern hemisphere. On the other hand, in temperate and tropical regions, the development of a free-swimming larva is so entirely the rule that it is usually described as the normal habit of the Echinodermata. This similarity in the mode of development between Arctic and Antarctic Echinoderms (and the contrast to what takes place in the tropics) holds good also in other classes of Invertebrates, and probably accounts for the absence of free-swimming larvæ of benthonic animals in the surface gatherings in Arctic and Antarctic waters.

What is urgently required with reference to the biological problems here indicated is a fuller knowledge of the facts, and it cannot be doubted that an Antarctic expedition would bring back collections and observations of the greatest interest to all naturalists and physiologists, and without such information it is impossible to discuss with success the present distribution of organisms over the surface of the globe, or to form a true conception of the antecedent conditions by which that distribution has been brought about.

Concluding Remarks.

There are many directions in which an Antarctic Expedition would carry out important observations besides those already touched on in the foregoing statement. From the purely exploratory point of view much might be urged in favour of an Antarctic Expedition at an early date; for the further progress of scientific geography it is essential to have a more exact knowledge of the topography of the Antarctic regions. This would enable a more just conception of the volume relations of land and sea to be formed, and in connection with pendulum observations some hints as to the density of the sub-oceanic crust and the depth of the Antarctic ice-cap might be obtained. In case the above sketch may possibly have created the impression that we really know a great deal about the Antarctic regions, it is necessary to re-state that all the general conclusions that have been indicated are largely hypothetical, and to again urge the necessity for a wider and more solid base for generalisations. The results of a successful Antarctic Expedition would mark a great advance in the philosophy—apart from the mere facts—of terrestrial science.

No thinking person doubts that the Antarctic will be explored. The only questions are: when? and by whom? I should like to see the work undertaken at once, and by the British Navy. I should like to see a sum of 150,000*l.* inserted in the estimates for the purpose. The Government may have sufficient grounds for declining to send forth such an expedition at the present time, but that is no reason why the scientific men of the country should not urge that the exploration of the Antarctic would lead to important additions to knowledge, and that, in the interests of science among English-speaking peoples, the United Kingdom should take not only a large but a leading part in any such exploration.

1 "Antarctic Voyage," p. 207.
2 Günther, "Study of Fishes, pp. 282–290. (Edinburgh, 1880.)

1 Murray and Barton, "Phycological Memoirs of the British Museum," Part 3. (London, 1895.)

THE ANTARCTIC ICE-SHEET: DUKE OF ARGYLL.

Scientific men generally feel, I think, that they do not need to give detailed reasons in connection with particular subjects of inquiry, to justify their unanimous desire for an Antarctic Expedition. It is enough, surely, for them to point out the fact that a very large area of the surface of our small planet is still almost unknown to us. That it should be so seems almost a reproach to our civilisation. As to detailed reasons, it may almost be said with truth that there is hardly one of the physical sciences on which important light may not be cast by Antarctic exploration. Oceanic circulation; meteorology; magnetism; distribution of animal and vegetable life, not only in the present but in the past; geology; mineralogy; volcanic action under special conditions —all of these are subjects on which the phenomena of the Antarctic regions are sure to bear directly.

If, however, I am asked to specify more particularly the question on which I look for invaluable evidence which can be got nowhere else, I must name, above all others, the most difficult questions involved in quaternary geology. Geologists are nearly all agreed that there has been, very recently, a glacial age—an age in which glacial conditions prevailed over the whole northern hemisphere to a much lower latitude than they prevail now. But geologists differ widely and fundamentally from each other as to the form which glacial agencies took during that period. In particular, many geologists believe in what they call an "ice sheet"—that is to say, in the northern world having been covered by an enormous mass of ice several thousand feet thick, which, as they assert, "flowed" over mountain areas as well as over plains, and filled up the bed of seas of a considerable depth. Other geologists disbelieve in this agency altogether. They deny that even such a body of ice ever existed; it could not possibly have moved in the way which the theory assumes. They affirm, also, that the facts connected with glaciated surfaces do not indicate the planing down by one universal sheet of enormous weight and pressure; but, on the contrary, the action of small and lighter bodies of ice, which have acted partially and unequally on different surfaces differently exposed.

We might have hoped that this controversy could be settled by the facts connected with the only enormous ice-sheet which exists in the northern hemisphere, viz. that which covers the great continent of Greenland. But that ice-sheet, enormous though it be, does certainly not do what the ice-sheet of the Glacial Age is supposed to have done. That is to say, it does not flow out from Greenland, fill the adjacent seas, or override the opposite coasts, even in so narrow a sheet as Smith's Sound. But this evidence is negative only. In the Antarctic continent we have reason to believe that there is a larger ice-sheet, and it certainly does protrude into the adjacent seas, not merely by sending out broken, floating fragments, but in unbroken ice cliffs of great height. Now we want to know exactly under what conditions this protrusion takes place. Dr. Murray speaks of it as "creeping" seawards—a more cautious word than "flowing." But is it certain that it does even creep? May it not simply grow by accretion or aggregation till it reaches a depth of water so great as to break it off by flotation? Does it, or does it not, carry detritus when no detritus has been dropped on its surface? Or does it pick up detritus from its own bed? Or does it push foreign matter before it? Does the perfectly tabular form of the Antarctic icebergs indicate any differential movement in the parent mass at all; or does it not indicate a condition of immobility until their buoyancy lifts great fragments off? What is the condition of the rocks on which they rest? Is there any thrust upon the mass from the mountain ranges on which the gathering ground lies? Or is the whole country one vast gathering ground from the continual excess of precipitation over melting? These questions, and a hundred others, have to be solved by Antarctic discovery; and until they are solved we cannot argue with security on the geological history of our own now temperate regions. The Antarctic continent is unquestionably the region of the earth in which glacial conditions are at their maximum, and therefore it is the region in which we must look for all the information attainable towards, perhaps, the most difficult problem with which geological science has to deal.

SIR JOSEPH HOOKER'S VIEWS.

Dr. Murray's admirable summary of the scientific information obtainable by an organised exploration of the Antarctic regions, leaves nothing further to be said under that head. I can only record the satisfaction with which I heard it, and my earnest hope that it will lead to action being taken by the Government in the direction indicated.

Next to a consideration of the number and complexity of the objects to be obtained by an Antarctic Expedition, what dwells most in my imagination, is the vast area of the unknown region which is to be the field for investigation—a region which, in its full extension, reaches from the latitude of 60° S. to the Southern Pole, and embraces every degree of longitude. This is a very considerable portion of the surface of the globe, and it is one that has been considered to be for the most part inaccessible to man; I will, therefore, ask you to accompany the scientific explorer no further than to the threshold of the scenes of his labours, that you may see how soon and how urgently he is called upon to study some of those hitherto unsolved Antarctic problems that he will there encounter.

In latitude 60° S. an open ocean girdles the globe without break of continuity. Proceeding southwards in it, probably before reaching the Antarctic Circle, he encounters the floating ice fields which form a circumpolar girdle known as "The Pack" approximately concentric with the oceanic, interrupted in one meridian only, that south of Cape Horn, by the northern prolongation of Graham's Land. Pursuing his southward course in search of seas or lands beyond, after the novelty of his position in the Pack has worn off, he asks where and how the component parts of these great fields of ice had their origin, how they arrived at, and maintain their present position, what are their rate of progress and courses, and what their influence on the surrounding atmosphere and ocean. I believe I am right in thinking that to none of these questions can a fuller answer be given, than that they originated over extensive areas of open water in a higher latitude than they now occupy, that they are formed of frozen ocean water and snow, and that winds and currents have brought them to where we now find them. But of the position of the southern, open waters, with the exception of the comparatively diminutive sea east of Victoria Land,[1] we know nothing, nor do we know anything of the relative amount of snow and ice of which they are composed, or of their age, or of the winds and currents that have carried them to a lower latitude.

The other great glacial feature of the Antarctic area is "The Barrier," which Ross traced for 300 miles in the 78th and 79th degree of south latitude, maintaining throughout its character of an inaccessible precipitous ice-cliff (the sea-front of a gigantic glacier) of 150 to 200 feet in height. This stupendous glacier is no doubt one parent of the huge table-topped ice-islands that infest the higher latitudes of the Southern Ocean; but as in the case of the Pack, we do not know where the Barrier has its origin, or anything further about it than that it in great part rests upon a comparatively shallow ocean bottom. It probably abuts upon land, possibly on an Antarctic continent; but to prove this was impossible, on the occasion of Ross's visit, for the height of the ship's crow's-nest above the sea-surface was not sufficient to enable him to overlook even the upper surface of the ice. Nor do I foresee any other method of settling this important point, except by the use of a captive balloon, an implement with which I hope that future expeditions may be supplied. There were several occasions in which such an implement might advantageously have been used by Ross when near the Barrier, and more when it would have greatly facilitated his navigation of the Pack.

I have chosen the Antarctic Ice as the subject upon which to address this most important meeting, not only because it is one of the very first of the phenomena that demand the study of the explorer, but because it is the dominant feature in Antarctic navigation, where the Pack is ever present or close by, demanding, whether for being penetrated or evaded, all the commander's fortitude and skill, and all his crew's endurance.

It may be expected that I should allude to those sections of Dr. Murray's summary that refer to the Antarctic fauna and flora; they are most important, for the South Polar Ocean swarms with animal and vegetable life. Large collections of these, taken both by the tow-net and by deep sea soundings, were made by Sir J. Ross, who was an ardent naturalist and threw away no opportunity of observing and preserving; but unfortunately, with the exception of the Diatomaceæ (which were investigated by

[1] I refer to the "pancake" ice, which, in that sea, on several occasions formed with great rapidity around Ross's ships, in lat. 76° to 78° S. in February 1842, and which arrested their progress. Such ice, augmented by further freezing of the water and by snowfalls, may be regarded as a genesis of fields that, when broken up by gales, are carried to the north and contribute to the circumpolar Pack.

Ehrenberg), very few of the results of his labour in this direction have been published. A better fate, I trust, awaits the treasures that the hoped-for expedition will bring back; for so prolific is that ocean, that the naturalist need never be idle, no, not even for one of the twenty-four hours of daylight throughout an Antarctic summer, and I look to the results of a comparison of the oceanic life of the Arctic and Antarctic regions as the heralding of an epoch in the history of biology.

THE PRACTICABILITY OF ANTARCTIC EXPLORATION.

Dr. Nansen said a great Antarctic Expedition should be undertaken by the British nation. He confined his observations to the great importance of a land expedition in the Antarctic continent. It would certainly be of the highest importance to have it in connection with a naval expedition, which would afford an excellent basis for such a land expedition. Dr. Murray had already mentioned the possibilities, and perhaps probabilities, that there was a large Antarctic continent covered by an ice-cap. They did not quite know yet. It might be that there were large islands, and there might be sounds in between covered with floating ice. Whether that was so or not, it was certain there must be one or several huge ice-caps inside this unknown territory in the South, and he felt certain that the exploration of these would give scientific information of the greatest importance. There were many problems to solve, and the only place they could try to solve them in was the polar regions. Greenland had already given them much information about the ice-sheet, but Greenland was too small, when compared with the big ice-sheets in the glacial packs. They should look to the much more extensive ice-sheets which they might find in the unknown territory. He did not think it would be very difficult to reach the Antarctic continent. They must remember they knew a great deal more about ice investigation than in the days of Ross. They had much better ships, and had steam, and were not afraid to push the ships into an ice-pack. They knew that if they were exposed to pressure and some hard times, they had the means to get out of it again; and his opinion was that in the Southern sea they were surrounded by much open water all round, and a ship would not run the risk of being shut up in ice as long as in the Arctic regions, where the seas were shut up by land round about. So far as he understood it, they would not run so much risk in that way in the South as in the Arctic. The ice generally opened in calm weather, and that was exactly when sailing-vessels would not be able to make use of the opportunity to get in. So he thought with their modern steamships it would not be difficult to get into the Antarctic. It had been said that the ice-sheet in the Antarctic continent was difficult to get at. It was difficult to ascend. Of course, when they went along the Barrier, as Ross did, it was difficult to get through, and probably the only way would be by captive balloons. He believed captive balloons would be of the greatest use for exploration in Polar regions. With regard to the probable thickness of the ice-sheet in the Antarctic, some put it at 2000 feet, some at 10,000 feet, but he would rather put it at 20,000 feet. The height might present considerable difficulty to any land expedition. This enormous ice-sheet must have an important influence upon the climatology of the whole world, and valuable information might be obtained as to meteorological conditions through an Antarctic expedition. If such a great naval expedition as had been suggested were sent from this country, Norway would gladly join in the work and send out another expedition to take part in the land work, and it would be of the greatest importance if there could be international co-operation in these expeditions, because simultaneous observations could then be made in these Antarctic regions, and they could lay their plans in a more scientific way.

DR. NEUMAYER ON GRAVITY AND TERRESTRIAL MAGNETISM.

A gravity survey is, in connection with a thorough geographical survey of the Antarctic, one of the most urgent requirements of the science of our earth. There are no measurements of the gravity constant within the Antarctic region; indeed, they are very scarce in the southern hemisphere south of 30° lat. S., and they are so closely connected with the theory of the figure of our earth that it is hardly possible to arrive at any conclusive results in this all-important matter without observations within the Antarctic region. It is impossible to foretell what effect an exact gravity survey in that region might exert upon our views with regard to all physical elements which depend upon the radius of our earth. Apart from that consideration, we may hope for another important enlargement of the knowledge bearing upon the connection between terrestrial magnetism and gravity. Gravity observations have been so much simplified of late, by von Herack's ingenious apparatus, that it does not offer a serious difficulty to multiply gravity determinations within the Antarctic region, so that we may well be able to speak of a "gravity survey." The all-important question of the distribution of land within the South Polar region is closely connected with it. The International Geodetic Permanent Commission expressed it as their conviction that a gravity survey within that region would be of the greatest benefit for higher geodetic theories.

The probable connection between gravity and terrestrial magnetism has already been referred to. But apart from this, a magnetic survey of the Antarctic region is of the greatest importance from other points of view. As, since the time of Ross, no other observations of the values of the magnetic elements have been made, we are perfectly ignorant of the values of the secular variations south of 50° lat., though this information is urgently needed for the construction of trustworthy magnetic charts required in navigation. Of the situation of the southern magnetic pole, and of its motion during the last fifty years, we are equally ignorant, though the facts are so highly important according to Gauss's theoretical deductions.

Much as the mathematical theory of terrestrial magnetism has been developed, of the physical theory of that mysterious force in nature we are yet in perfect ignorance. This defect is certainly to some considerable degree caused by the want of our knowledge in higher latitudes. It seems as if the magnetic character of the South Polar region is such as would afford all facility for a sound investigation when compared with the magnetic conditions of the North Polar region. A glance at a magnetic map shows how entirely different is the distribution of the magnetic action in both polar regions.

There is the interesting fact to be noticed in the south that the two foci of total intensity are situated on the side towards the south of the Australian continent, and nearly on the same meridian. The magnetic action which makes itself manifest by magnetic storms or disturbances reaches its highest degree likewise south of the Australian continent, whereas to the south of South America the storms become very scarce and of a similar magnitude to those in middle latitudes. This was most strikingly proved by the observations in Orange Bay and South Georgia during the period of international observations in 1882-83. Of course the magnetic south pole and the situation of the foci above mentioned, are in close connection with these facts, but the reason of their distribution remains unexplained. A discussion of all observations on southern polar lights also shows a connection between their frequency and the maximum region of magnetic disturbance.

Though the examination of these few facts ought to prompt the institution of a vigorous examination of the south polar regions, the series is far from being exhausted: there is the question of the geoid-deformation, the phenomena of the tides, and the structure of the ice and its drifting.

The resolution of the Sixth International Geographical Congress that the present century should not be allowed to expire without unveiling the mysteries of the south polar regions, ought to be carried into effect. All scientific institutions and societies trust that such will take place without any further delay.

SIR CLEMENTS MARKHAM ON ANTARCTIC GEOGRAPHY.

I need scarcely say how fully I concur in every word that has fallen from Dr. Murray on the subject of the scientific results, and more especially of the geographical results of an Antarctic Expedition.

It is sufficient to point out the vast extent of the unknown area, and that no area of like extent, on the surface of the earth, ever failed to yield results of practical, as well as of purely scientific interest by its exploration.

But there is much more to be said in the present instance: because the little that we do know of the Antarctic regions points unerringly to the very great importance and interest of the results that are certain to attend further research.

The ice barrier, discovered by Sir James Ross, is known to be the source of the immense ice islands of the southern polar sea. But it has only been seen for a distance of 300 miles. It requires far more complete examination before any approach to an adequate knowledge can be obtained, respecting the extent and nature of the supposed ice-cap in its rear.

We know that the southern continent is a region of actual volcanic activity; but the extent, nature, and effect of that activity remain to be ascertained.

On the Antarctic Circle land has been reported at numerous points, south of Australia and the Indian ocean, but it is unknown whether what has been seen indicates islets and rocks, or a continuous coast-line.

Dr. Murray has pointed out that the whole southern continent is certainly not bounded by such an ice-wall as was seen by Sir James Ross, and is not covered by an ice-cap. But the extent alike of the ice-cap and of the uncovered land is unknown.

We are ignorant of the distribution of land and sea, and of ice and water in summer, and of the causes which influence such distribution.

These are some of the geographical problems to be solved. The investigation of each one of them will lead to further discoveries as yet undreamt of, which must needs be of the deepest interest to geographers.

There are eminent men present who will no doubt refer to the results of Antarctic exploration as regards other branches of science. Combined together they make the discovery of the unknown parts of the Antarctic region the greatest and most important work that remains for this generation of explorers to achieve.

METEOROLOGY AND ANTARCTIC EXPLORATION.

Dr. Alexander Buchan stated that the remarks he was about to make would have exclusive reference to the first two paragraphs of Dr. Murray's address, under the heading of "The Atmosphere"; or, rather, more immediately to the relation between mean atmospheric pressure and prevailing winds. He supposed he had been asked to speak on this occasion, from the extensive and minute knowledge of the subject he had necessarily acquired in the preparation of the reports on atmospheric and oceanic circulation which were published as two of the reports of the scientific results of the voyage of H.M S. *Challenger*.

The former of these reports, on atmospheric circulation, is accompanied by twenty-six maps, showing by isobars for each month and the year the mean pressure of the atmosphere, and by arrows the prevailing winds of the globe, on hypsobathymetric maps, or maps showing by shadings the height of the land and the depth of the sea; first on Gall's projection, and second on north circumpolar maps on equal surface projection. The isobars are drawn from mean pressures calculated for 1366 places, and the winds from even a larger number of places, distributed as well as possible over the whole globe. It is also of importance to note that averages of pressure and prevailing winds are published with the report—an accompaniment to the maps of mean atmospheric pressure and prevailing winds of the globe not yet given in any other series of maps of mean pressure and prevailing winds.

This then is the work undertaken and published in these reports, which occupied seven years in preparing, as time could be spared from official duties. The result of the charting of the pressure and prevailing winds is this: stand with your back to the wind, then the centre of lowest pressure that causes the wind will be to the left in the northern hemisphere, and to the right hand in the southern hemisphere, a relation well known as Buys Ballot's law. In charting the 1366 pressures and the relative prevailing winds, no exception was found in any of the two hemispheres. This is one of the broadest generalisations science can point to.

Some years ago a theory of atmospheric circulation was published by the late Prof. Ferrel which, as it is not accordant with the broad results arrived at in the report of atmospheric circulation in the *Challenger* Reports, calls for serious consideration on account of its bearing on any attempt proposed to be undertaken for the exploration of the Antarctic regions.

One of the more recent expositors of this theory is Prof. Davis, of Harvard College, who, in his "Elementary Meteorology," gives an admirable exposition of the results now arrived at by the various workers in meteorology, and of the opinions and theories promulgated by different meteorologists in different departments of the science. The book is largely used in secondary schools and colleges of the United States, and these views are all but universally held there, and are now spreading over other countries.

The following extracts from Davis's book fairly represent these views as generally entertained.

"The surface winds of the temperate latitudes, and the high-level currents above them, sliding swiftly along on their steep poleward gradients, must all be considered together. They combine to form a vast aerial vortex or eddy around the pole. In the northern hemisphere this great eddy is much interrupted by continental high pressure in winter, or low pressure in summer, and by obstruction from mountain ranges, as well as by irregular disturbances of the general circulation in the form of storms" (p. 110).

Now the facts of observation do not support the theory of the existence, at any season of the year, of a low barometric pressure, or an eddy of winds, round or in the neighbouring regions of the north pole. Observations do not show us any prevailing winds blowing homewards to the north pole at any time of the year. Further, no low barometric pressure occupies the immediate polar region in any month; but instead, the opposite holds good for the four months from April to July. In April and May the mean atmospheric pressure is higher in the region of the pole than it is anywhere in the northern hemisphere north of 43° lat. N.; and in June and July, also higher than it is anywhere north of 55° lat. N. Now the higher pressure in these four months necessitates the existence of upper currents in order to maintain this high pressure about the north pole. These upper currents toward the pole are exactly opposed to the requirements of the theory, which intimates that the upper currents in the region of the pole must necessarily blow not towards but from the pole.

The actual centre in this hemisphere, north of the tropics, towards which the winds on or near the surface of the earth blow, is not the north pole; but, in the winter months, the low barometric depressions in the north of the Atlantic and Pacific respectively, and in the summer months, the low barometric depressions in the Eurasian and North American continents; and the sources out of which the prevailing winds blow, in the winter months, the high pressure regions in Siberia and North America; and in the summer months, the high pressure regions lying northward of these continents, which, as already explained, are virtually the polar region itself. These are the facts in all regions where the winds, according to the theory, become winds blowing over the earth's surface.

As regards the southern hemisphere, Prof. Davis states that—

"In the southern hemisphere the circumpolar eddy is much more symmetrically developed." Again, "the high pressure that should result from the low polar temperatures is therefore reversed into low pressure by the excessive equatorward centrifugal force of the great circumpolar whirl; and the air thus held away from the polar regions is seen in the tropical belts of high pressure" (pp. 110, 111).

The interpretation of this is that the remarkable low-pressure region of the southern hemisphere is continued southward to the south pole itself, the pressure diminishing all the way; and that in the region of the south pole, the air currents poured thitherwards along the surface of the earth, ascend, and thence proceed northwards as upper currents of such enormous intensity and volume, that they pile up in the tropical region of the southern hemisphere a mean sea-level atmospheric pressure about an inch and a half more than the sea-level pressure near the south pole whence it starts. Now, to bring the matter to the business which this meeting of the Royal Society has taken in hand—if this theory be true and supported by the facts of observation, it is plain that no meteorologist could signify his approval of any scheme that could be proposed for exploring the Antarctic regions, it being obvious that these strong west-north-westerly winds, if they blow vortically round and in upon the pole, heavily laden, as they necessarily would be with the aqueous vapour they have licked up from the Southern Ocean, would overspread Antartica with a climate of all but continuous rain, sleet, and snow, which no explorer, however intrepid and enthusiastic, could possibly face.

But is this the state of things? Let it be at once conceded that, as far south as about 55° lat. S., the prevailing winds and the steadily diminishing mean pressures on advancing southward fairly well support the theory. South of this, however, southerly and south-easterly winds begin to increase in frequency, until from 60° lat. S. into higher latitudes, they become the prevailing winds. This is abundantly shown from the winds charted on the maps of the *Challenger* Report, as well as from the unanimous experience of all those who have navigated this region from Ross to the present time. Thus the poleward blowing winds from west-north-west in these summer

months stop short, at least, thirty degrees of latitude from the south pole.

These prevailing S.S.E. winds necessarily imply, as has been shown in the case of the north pole, the existence of a more or less pronounced anticyclone overspreading Antarctica; which in its turn necessarily implies the existence of upper currents from the northward, blowing towards and in upon the polar region to make good the drain caused by the surface out-blowing southeasterly winds. It may therefore be concluded that both the surface winds and the upper aerial currents are diametrically opposed to the requirements of this theory.

What is now urgently called for is a well-equipped Antarctic Expedition to make observations which will enable meteorologists to settle definitely the distribution of atmospheric pressure and the prevailing winds of this great region. Were this done, the position in the Southern Ocean of the great ring of lowest pressure that encircles the globe could be mapped out; and since it is towards this low-pressure ring that the wind-driven surface currents of the ocean flow, a contribution would thereby be made to oceanography, of an importance that cannot be over-estimated, particularly as regards the great question of oceanic circulation.

Sir Archibald Geikie on Antarctic Geology.

Hardly anything is yet known of the geology of the Antarctic regions. By far the most important contributions to our knowledge of the subject were made by the expedition under Sir James Ross. But as he was unable to winter with his ships in the higher latitudes, and could only here and there with difficulty effect a landing on the coast, most of the geological information brought home by him was gathered at a greater or less distance from the land, with the aid of the telescope. Within the last few years several sealing vessels have brought home some additional scraps of intelligence, which only increase the desire for fuller knowledge.

As regards the land, merely its edges have here and there been seen. Whether it is one great continent or a succession of islands and archipelagos may possibly never be ascertained. We know that in Victoria Land it terminates in a magnificent mountain-range with peaks from 10,000 to 15,000 feet high; but that elsewhere it is probably comparatively low, shedding its ice-cap in one vast sheet into the sea.

The rocks that constitute the land are still practically unknown. The dredgings of the *Challenger* Expedition brought up pieces of granite, gneiss, and other continental rocks, and detritus of these materials was observed to increase on the sea-floor southwards in the direction of the Antarctic land. More recently several sealing vessels have brought home from the islets of Graham Land to the south of the South Shetlands pieces of different varieties of granite, together with some volcanic rocks and fossiliferous limestones. So far as these rocks have been studied, they do not appear to differ from similar rocks all over the globe. The granites have been found by Mr. Teall to be just such masses as might have come from any old mountain group in Europe or America.

Among the specimens sent to me by Captain Robertson, of the *Active*, from Joinville and Dundee Islands, which form the north-eastern termination of Graham Land, there was one piece of reddish jasper which at once attracted my attention from its resemblance to the "radiolarian cherts" now found to be so widely distributed among the older Palæozoic rocks, both in the Old World and in the New. On closer examination, this first impression was confirmed; and a subsequent microscopic study of thin slices of the stone, by Dr. Hinde, proved the undoubted presence of abundant radiolaria. The specimen was a loose pebble picked up on the beach of Joinville Island. We have no means of telling where it came from, or what is its geological age. But its close resemblance to the radiolarian cherts so persistent in the Lower Silurian formations of the United Kingdom, raises the question whether there are not present in the Antarctic regions rocks of older Palæozoic age.

It would be of the utmost interest to discover such rocks *in situ*, and to ascertain how far their fossils agree with those found in deposits of similar antiquity in lower latitudes; or whether, as far back as early Palæozoic time, any difference in climate had begun to show itself between the polar and other regions of the earth's surface.

Among the specimens brought home by Dr. Donald and Captain Larsen from Seymour Island, in the same region, are a few containing some half-dozen species of fossil shells which have been named and described by Messrs. Sharman and Newton, who suggest that they point to the existence of Lower Tertiary rocks, one of the organisms resembling a form found in the old Tertiary formations of Patagonia. Large well-developed shells of *Cucullæa* and *Cytherea* undoubtedly indicate the former existence of a far milder climate in these Antarctic seas than now prevails.

If a chance landing for a few hours on a bare islet could give us these interesting glimpses into the geological past of the south polar regions, what would not be gained by a more leisurely and well-planned expedition?

But perhaps the geological domain that would be most sure to gain largely from such exploration would be that which embraces the wide and fascinating field of volcanic action. In the splendid harvest of results brought home by Sir James Ross, one of the most thrilling features was the discovery of a snowy volcanic cone rising amid the universal snows of Victoria Land to a height of more than 12,000 feet, and actively discharging "flame and smoke," while other lofty cones near it indicated that they too had once been in vigorous eruption. Ross landed on one or two islands near that coast, and brought away some pieces of volcanic rocks.

If we glance at a terrestrial globe we can readily see that the volcanic ring or "circle of fire," which nearly surrounds the vast basin of the Pacific Ocean, is prolonged southwards into New Zealand. The few observations that have been made in the scattered islands further south show that the Auckland, Campbell, and Macquarrie groups consist of, or at least include, materials of volcanic origin. Still further south, along the same general line, Mr. Borchgrevink has recently (1894-95) made known the extension of Ross's volcanic platorm northwards to Cape Adare, the northern promontory of Victoria Land. He noticed there the apparent intercalation of lava and ice, while bare snowless peaks seemed still further to point to the continued activity of the volcanic fires. Some specimens brought by his expedition from Possession Island, were found by Mr. Teall to be highly vesicular hornblende-basalt, while one from Cape Adare was a nepheline-tephrite. This region is probably one of the most interesting volcanic tracts on the face of the globe. Yet we can hardly be said to know more of it than its mere existence. The deeply interesting problems which it suggests cannot be worked out by transitory voyagers. They must be attacked by observers stationed on the spot. Ross thought that a winter station might be established near the foot of Mount Erebus, and that the interior could easily be traversed from there to the magnetic pole.

But it is not merely in Victoria Land that Antarctic volcanoes may be studied. Looking again at the globe, we observe that the American volcanic band is prolonged in a north and south line down the western side of the southern continent. That it has been continued into the chain of the South Shetlands and Graham Land is proved by the occurrence there of old sheets of basalt, rising in terraces over each other, sometimes to a height of more than 7000 feet above the sea. These denuded lavas may be as old as those of our Western Isles, Faroe, Iceland, and Greenland. But that volcanic activity is not extinct there has recently been found by Captain Larsen, who came upon a group of small volcanoes forming islets along the eastern coast-line of Graham Land. It is tantalising to know no more about them.

Another geological field where much fresh and important information might be obtained by Antarctic exploration is that of ice and ice-action. Our northern hemisphere was once enveloped in snow and ice, and though for more than half a century geologists have been studying the traces of the operations of this ice-covering, they are still far from having cleared up all the difficulties of the study. The Antarctic ice-cap is the largest in the world. Its behaviour could probably be watched along many parts of its margin, and this research would doubtless afford great help in the interpretation of the glaciation of the northern hemisphere.

To sum up:—Geologists would hail the organisation and despatch of an Antarctic Expedition in the confident assurance that it could not fail greatly to advance the interests of their science. Among the questions which it would help to elucidate, mention may be made of the following:—

The nature of the rocks forming the land of the Antarctic region, and how far these rocks contain evidence bearing on the history of terrestrial climates.

The extent to which the known fossiliferous formations of our globe can be traced towards the poles; the gaps which may occur between these formations and the light which their study may be able to throw on the evolution of terrestrial topography.

The history of volcanic action in the past, and the conditions under which it is continued now in the polar regions; whether in high latitudes vulcanism, either in its internal magmas or superficial eruptions, manifests peculiarities not observable nearer to the equator; what is the nature of the volcanic products now ejected at the surface; whether a definite sequence can be established from the eruptions of still active volcanoes back into those of earlier geological periods in Antarctic lands; and whether among the older sheets leaf-beds or other intercalations may be traceable, indicating the prolongation of a well-developed terrestrial flora towards the south pole.

The influence of the Antarctic climate upon the rocks exposed to its action; the effects of contact with ice and snow upon streams of lava; the result of the seaward creep of the ice-cap in regard to any lava-sheets intercalated in the ice. It is conceivable that portions of lava-streams might be broken off by the onward motion of the ice which they overspread, and might thus be carried out to sea, intercalated in or capping ice-bergs.

The physics of Antarctic ice in regard to the history of the Ice Age in northern Europe and America.

Antarctic Fauna.

Although an ardent advocate of Antarctic exploration, Mr. Sclater acknowledged that, as regards the higher vertebrates, with which he was most conversant, there was little chance of the discovery of new forms of animal life in the South Polar continent. The Antarctic mammals and birds (of the latter of which about twenty species were known) were exclusively of marine forms. Not a single land-mammal or land-bird had been yet obtained in Antarctica. As regards the class of fishes and the marine invertebrates, the case was quite different, and great discoveries might be anticipated in these groups, where very little had yet been done. The most promising zoological subject of Antarctic exploration seemed to him, however, to be the further investigation of the extinct fauna. The few fossil remains already obtained indicated the former existence in the South Polar area of a very different climate from that which now prevailed there, and further researches on this point might lead to most important results.

Prof. D'Arcy W. Thompson said that all we knew of the deep-sea life of the Antarctic came from eight hauls of the dredge, which hauls were, by common consent of the naturalists of the *Challenger*, the most productive of the whole cruise. The fauna of every ocean urgently demanded further exploration, for we knew now no more about the fauna of the deep-sea than was known a hundred years ago of the fauna of the shore. But the circumpolar fauna of the South, at the meeting of all the great oceans, presented problems of peculiar importance. He considered Dr. Murray's theory of a "bipolar fauna," closely akin both in the Arctic and Antarctic, as not proven; but he believed that there were many remarkable cases of continuous distribution, especially along the cold waters of the Western American coast from the Antarctic into the North Pacific, and even to Japan. If the "bipolar hypothesis" were broken down, Antarctic exploration would lead to new generalisations, not less interesting, to take its place.

Admiral Sir William Wharton said that an Antarctic Expedition must be under naval discipline. He hoped that such an expedition would not be far off, and he felt sure there would be a rush of officers and men to join it.

Sir John Evans, in briefly summing up the discussion, said it had maintained a high level, and that the meeting had been prolonged to an unprecedented hour in the Royal Society. All were agreed as to the immense advantages of an expedition, and he was sure it would find a warm advocate in the Hydrographer to the Admiralty.

ON THE ABSORPTION OF LIGHT BY FLUORESCING BODIES.[1]

MR. JOHN BURKE has recently given to the Royal Society of London (see Nature, vol. lvi. p. 261) the result of some experiments which afford an important indication of the mode of action of bodies during fluorescence, and which may lead to a clearer conception of Kirchhoff's law on the equality of the emissive and absorptive powers of bodies.

The following is one form of Mr. Burke's experiment:—A photographic plate, P (Fig. 1), is adjusted before two equal cubes of uranium glass, A and B, placed so that the light emanating from B is obliged to pass through A before reaching the photographic plate P.

The source of light, S, rich in the ultra-violet, illuminates the cubes by rays parallel to the plate, which is screened from the direct action of the source. An image is first formed by letting the exciting rays act on the two cubes simultaneously. The plate is then displaced, and a second image is produced by illuminating each of the cubes separately, each for the same length of time as in the first experiment.

The result is that on development the resultant impression of the two separate effects is always much more intense than that of the first due to the two conjointly.

The simplest explanation of this curious phenomenon is to suppose that the cube A absorbs the light emitted by the cube B more strongly when it is in a state of fluorescence than when it is screened from the exciting source. At first sight this property of fluorescent bodies appears to be a direct consequence of Kirchhoff's law, all luminous bodies absorbing the radiations which they are capable of emitting. But on looking at the matter more closely we find that this law, which includes so many facts, does not directly apply to the phenomenon discovered by Mr. Burke. This law states, in general, that all bodies, *at a given temperature*, have an emissive power and an absorptive power which are equal for each kind of radiation they emit. But we see here a class of bodies which, without having their temperature visibly altered, have their absorptive power changed, in consequence of the fact that, by a cause apparently different from an elevation of temperature, they emit, momentarily, and under the action of an external source, radiations which are extinguished at the same time as the excitation itself. By this excitation the molecule is not permanently altered, and it does not become susceptible of vibrating in unison with the light to which it had attained; but if, by an external cause, it is given this vibratory movement, then, and only then, it becomes a resonator for the radiations identically the same as that which it emits.

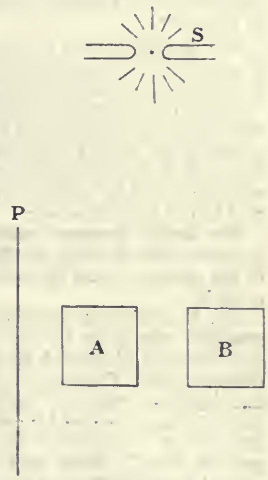


Fig. 1.

A familiar illustration will give us a more vivid conception of the mechanism of the phenomenon. Let us suppose a sound wave to approach a fixed tuning-fork of another pitch; the wave will pass on unabsorbed. But if we force the tuning-fork in such a way as to make it emit a note identical with that of the wave which approaches it, then it will behave as a resonator and will evidently become absorbent to the passing wave. The tuning-fork is thus capable of absorbing the vibratory energy which reaches it, not merely when the latter corresponds to its natural period of vibration, but also when it possesses a period identical with that of the forced vibration that is momentarily imparted to it.

It is probable, similarly, that the fluorescent molecules are excited momentarily to a forced vibration, and become, *for an instant*, susceptible of absorbing the vibrations of the same period.

It will be found, perhaps, that the familiar statement of Kirchhoff's law will apply, on comparing the small number of fluorescent molecules in the uranium glass, to any molecules whatsoever which have been raised to a fictitious temperature corresponding to their vibratory state. This extension of the notion of temperature has already been suggested with regard to various luminous phenomena other than that of incandescence, but it had merely led, up to the present, to the heaping up of difficulties without arriving at anything conclusive.

It seems to me far simpler to suppress the notion of *temperature* altogether in Kirchhoff's law, which is far too general to be limited by a conception that ought to have a precise and definite signification.

[1] Translation of a paper, by Prof. C. E. Guillaume, in the *Revue Générale des Sciences*, December 15, 1897.

THE STRUCTURE OF CRYSTALS.[1]

IT is impossible here to do more than call attention to these two memoirs; the subject with which they deal is too intricate to be intelligible without the aid of diagrams.

The author of the first appears to hold quite peculiar views on the nature of valency and chemical combination Each atom is surrounded by a "sphere of action," and this represents the volume of the element; whereas the volume of a compound molecule is less than the sum of the volumes of its components, for their spheres of action are supposed to interpenetrate to a certain extent when combination takes place. Their partial interpenetration gives rise to a complex surface of action for the molecule, which may be of a polar character, and approximates in form to a sphere when the molecule consists of a large number of atoms. Crystallisation is due to the attractive juxtaposition of such polar molecules. For the author's general views the reader is referred to his previous work, "Die Kraft und Materie in Raume."

The present memoir is an elaborate study of the development of a number of complex forms by the superposition of spheres layer by layer on one or other of a few simple "embryos"; for example, on a tetrahedron composed of four equal spheres in contact. The whole process is illustrated by twenty-six excellent plates, which appear to be photographs of skilfully constructed stacks of balls. On all matters the author expresses himself with remarkable confidence, and claims to have solved the problem of crystallisation.

We doubt, however, whether all the types of crystalline symmetry are covered by the author's hypotheses, and some of his groups appear to be incompatible with what is known of crystals.

Mr. Barlow's first communication on the subject of crystalline structure was made to this journal (vol. xxix. p. 186) in 1883, and was also illustrated by the regular grouping of spheres of different sorts. That paper was characterised as "an interesting and ingenious memoir" by the late Prof. Sohncke, who expressed the hope that his own criticisms (p. 383) would induce the author "to establish his theory in a more solid and more general way." Since that date Mr. Barlow has published several investigations on the subject, and the present memoir, which appears in the scientific *Proceedings* of the Royal Dublin Society, is an extended study of the close-packing of spheres of different sizes. In the arrangement and re-arrangement of such stacks he ingeniously traces a number of interesting analogies which lead him far beyond the features of mere crystalline growth and structure into chemical combination and decomposition, solution, diffusion, and the phenomena classed under stereo-chemistry.

Mr. Barlow himself regards the close packing of spheres as representing the position of equilibrium of mutually repellent particles, and this he believes to be the key to all the problems considered; but the reader must be referred to the original memoir for the details.

The study of crystalline structure as represented by the close packing of spheres or other figures is now being prosecuted by several investigators in very different ways, and with very different interpretations. The geometry of the subject is, of course, independent of all the speculations which gather round it, and deserves the very serious attention of chemists and physicists.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. Oldham, the University Lecturer in Geography, announces a public lecture on the North-west Frontier of India. Sir George Robertson, K.C.S.I., of Chitral fame, will take the chair.

The late Mr. Frank Chance has bequeathed 400 volumes to the University Library.

The Museums Syndicate report that owing to the increase of the number of buildings under their charge, and the greater requirements for research and other students, the sum placed at their disposal for the annual maintenance of the scientific departments must be augmented by 300*l.*

[1] "Das Problem der Krystallisation." By A. Turner. Pp. 98; 26 plates. (Leipzig: 1897.)
"A Mechanical Cause of Homogeneity of Structure and Symmetry geometrically investigated; with special application to Crystals and to Chemical Combination." By W. Barlow. Pp. 164. (Dublin: 1897.)

A proposal is made by the Local Lectures Syndicate for the granting of a diploma in Arts to University Extension students who have passed through a prescribed course of study and examinations.

DR. GOTTLIEB, assistant professor of pharmacology in the University of Heidelberg, has been provisionally appointed successor to the late Prof. Dr. W. von Schroeder.

MR. A. E. BRISCOE has been appointed Principal of the new technical institute in course of erection at Stratford. Mr. Briscoe is at present head of the Physics and Electrical Department of the Battersea Polytechnic.

REFERRING to the London University Commission Bill, 1898, which was introduced into the House of Lords by the Lord President of the Council on February 21, and read a first time, the *British Medical Journal* points out that it differs from the Bill of 1897 in the omission of the names of the Commissioners. From the schedule appended to the Bill it appears that the constitution of the Senate is modified by giving to the Council of the City and Guilds of London Institute one member, and by reducing the number of Crown nominees from five to four. The number of members of the Senate is thus retained at the same figure, fifty-five, or with the Chancellor, fifty-six. In the paragraph dealing with Faculties, the sub-section recognising examiners appointed by the University as members of the Faculties has been omitted. The instructions to the Commissioners as to examinations are practically the same, and the Senate will be required to hold separate examinations for internal and external students unless it otherwise determine, "either generally by regulation, or as to a particular subject by order." But there is this rather important addition, that the Senate will be required to communicate any such regulation to Convocation. Part II. of the Schedule is now headed, "Matters for which provision must be made." These include the adequate protection of all classes of students whether external or internal, collegiate or non-collegiate, the recognition of teachers of the University, and the regulations for the admission of internal students. The sub-clause dealing with this last point has been modified, and as it nows reads persons to be recognised as internal students will be "students who have matriculated at the University, and are pursuing a course of study approved by the University under one or more of the recognised teachers of the University."

THE official report of the *Proceedings* of the recent annual general meeting of the Association of Technical Institutions, containing the address delivered by the President, the Right Hon. Sir Bernhard Samuelson, Bart., F.R.S., has been issued. In the course of his remarks the President pointed out that much good will arise from the concordance between the various educational agencies which has been arrived at in ten or twelve county boroughs, one of the most conspicuous examples of which is Manchester, where the School Board, the City authorities with their splendid technical schools, and the Owens College of the Victoria University are all acting in harmony, and constructing the ladder so much talked of, but still so rarely provided, on which a child can by intelligence and perseverance mount from the humblest to the highest intellectual position. As to the expenditure of the funds available for technical instruction. Sir Bernhard Samuelson presented the following questions to his audience:—Have we fully considered the relative value of the various degrees of technical education; would it have been better for the nation if the 800,000*l.* per annum of Customs and Excise Fund had been in the main devoted to the higher rather than to the primary and secondary grades of technical education? Would not the lower grades even have been better served if we had in the first instance made a determined effort to extend and improve general elementary and secondary education? Many educationists would answer these questions in the affirmative.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 3.—"Researches in Vortex Motion. Part III. On Spiral or Gyrostatic Vortex Aggregates." By W. M. Hicks, F.R.S.

The chief part of the paper refers to a kind of gyrostatic aggregate. The investigation has brought to light an entirely new system of spiral vortices.

The general conditions for the existence of such systems are determined, and are worked out in more detail for a particular case of spherical aggregate. It is found that the motion in meridian planes is determined from a certain function ψ in the usual manner. The velocity along a parallel of latitude is given by $v = f(\psi)/\rho$ where ρ is the distance of the point from the straight or polar axis. The function ψ satisfies an equation of the form (when expressed in polar coordinates)

$$\frac{d^2\psi}{dr^2} + \frac{1}{r^2}\frac{d^2\psi}{d\theta^2} - \frac{\cot\theta}{r^2}\frac{d\psi}{d\theta} = \rho^2 F - f\frac{df}{d\psi},$$

where F and f are both functions of ψ. The case F uniform, and $f \propto \psi$ is treated more fully. If $f = \lambda\psi/a$ where a is the radius of the aggregate,

$$\psi = A\left\{J_2\left(\frac{\lambda r}{a}\right) - \frac{r^2}{a^2}J(\lambda)\right\}\sin^2\theta.$$

The most striking and remarkable fact brought out is that as λ increases we get a periodic system of families of aggregates. The members of each family differ from one another in the number of layers and equatorial axes they possess. According to the number of independent axes they are called singlets, doublets, triplets, &c., in contradistinction to more or less fortuitous or arbitrary compounds of the former which are considered later and called monads, dyads, triads, &c. Of these families two are investigated more in detail than the others, both because they are specially interesting in their properties and because they serve as limiting cases between the different series. In one family (the λ_2 family) all the members remain at rest in the surrounding fluid. In the other (the λ_1 family) a distinguishing feature, common to all the members, is that the stream lines and the vortex lines are coincident.

The parameter λ gives the total angular pitch of the stream lines on the outer current sheet. The first aggregates—with $\lambda < 5{\cdot}7637$ (the first λ_2 value)—behave abnormally. Beyond these we get successive series, in one set of which the velocity of translation is in the same direction as the polar motion of the central nucleus, in the alternate set the velocity is opposite, and the aggregate regredes in the fluid as compared with its central aggregate.

At the end of the paper a theory of compound aggregates is developed. It is not worked out in detail in the present communication, but the conditions are determined for dyad compounds, whilst a similar theory holds for triad and higher ones. Each element of a poly-ad may consist of singlets, doublets, &c. The equations of condition allow three quantities arbitrary—as for instance ratio of volumes, ratio of primary cyclic constants, and ratio of secondary cyclic constants.

At the end of the abstract, illustrations of the relations of the theory to the vortex cell theory of the ether, and to the periodic law of the chemical elements are touched upon.

February 10.—"The Development and Morphology of the Vascular System in Mammals. The Posterior End of the Aorta and the Iliac Arteries." By Alfred H. Young, M.B., F.R.C.S., and Arthur Robinson, M.D.

Though numerous observations have been made on the development of the systemic aorta and on the aortic arches, including their modifications and transformations at the head end of the embryo, but little attention has hitherto been given to the development and modifications of the primitive vessels and the aortic arches at the caudal end.

The view that the primitive aortæ are prolonged backwards from the dorsal region into the tail, and that, fusing there, they form a caudal aorta—the middle sacral artery—seems to be generally accepted by embryologists. The iliac arteries are accordingly regarded as segmental vessels.

Observations on the development of the posterior end of the aorta and its terminal branches in mammals point, however, to very different conclusions.

The primitive aortæ are not directly continued into the middle sacral artery, but into primary caudal arches, one on each side, the ventral continuations of which either fuse together to form a common vitello-allantoic stem, as in rodents, or they remain separate and form the ventral parts of the allantoic arteries, as in carnivores, ruminants and man.

The middle parts of the primary caudal arches disappear and are replaced by "secondary" caudal arches which lie to the outer sides of the Wolffian ducts. In rodents and man the secondary arches are transformed into the common and internal iliac arteries and the dorsal parts of the hypogastric arteries, whilst in carnivores they are probably transformed into the posterior part of the adult aorta and into the internal iliacs and dorsal parts of the hypogastric arteries.

The vessels, which are to be looked upon as the posterior continuations of the primitive aorta in the adult in man, rodents, &c., are the common iliac, internal iliac, and hypogastric arteries, and in carnivores, &c., the internal iliac and hypogastric arteries.

The common and internal iliac arteries are not segmental vessels, their branches may be.

The middle sacral artery is a secondary branch, probably representing fused segmental vessels.

The permanent adult aorta, in so far as it is formed by the primitive dorsal aortæ, ends posteriorly either at the bifurcation into the two common iliac arteries or at a point corresponding to this bifurcation, when by more extensive fusion involving the dorsal parts of the secondary arches there are no common iliacs, and the external and internal iliac arteries appear to arise directly and separately from the aortæ. In each case the continuity of the primitive aorta is interrupted; the primary caudal arches are replaced by secondary caudal arches, after which the continuations of the aorta are represented by the vessels into which the secondary caudal arches are ultimately transformed.

These conclusions are further supported by more extended observations on the anatomy of the posterior end of the aorta, and its terminal branches in mammals, and on the abnormalities they present in man.

"Further Observations upon the Comparative Chemistry of the Suprarenal Capsules, with Remarks upon the Non-existence of Suprarenal Medulla in Teleostean Fishes." By B. Moore, M.A., and Swale Vincent, M.B.

In a previous communication these authors have shown that the paired segmental suprarenals of Elasmobranchs contain a chromogen giving the same reactions as that of the medullary portion of the suprarenal capsule of higher vertebrates, while the inter-renal body in the same order of fishes contains no such chromogen.

Now the suprarenal bodies of Teleosts do not contain the physiologically active principle which is characteristic of suprarenal medulla, and the natural conclusion would seem to be that the representative of the medulla is absent. But further evidence is desirable.

A decoction from the suprarenal bodies of *Gadus morrhua* and *Anguilla anguilla* was carefully tested for the chromogen, with entirely negative results. The lymphoid "head-kidney" was also tested, as well as other portions of the kidney, but no trace of the chromogen was found.

From these observations, combined with those previously made, the authors are forced to the conclusion that *the medullary portion of the suprarenal capsules is non-existent in Teleostean fishes.*

"The Effects of Extirpation of the Suprarenal Bodies of the Eel (*Anguilla anguilla*)." By Swale Vincent, M.B.

Teleostean fishes, having only suprarenal cortex, seemed to offer an admirable opportunity of testing how far these "cortical glands" were essential to the life of the animal. Accordingly, a series of extirpation experiments were performed upon the eel.

In three cases in which the animals survived the operation, they appeared quite lively soon after being put back in the tank. One survived twenty-eight days, another sixty-four days, and a third was killed on the 119th day. These experiments show that an eel will survive the operation of extirpation for a very much longer time than mammals or frogs; and the difference is so striking that one must attribute it to the absence of medulla in Teleosts, and must assume that *the cortical gland is not absolutely essential to the life of the animal.* The longest time that a frog will survive removal of its capsules is twelve or thirteen days. Mammals usually die in a day or two.

The validity of these experiments depends upon the actual removal of all suprarenal. This was verified in two ways. (1) Previous study showed that the bodies in the eel are never more than two. (2) All three eels were dissected *post-mortem*, and no trace of suprarenal was found left behind.

Chemical Society, February 17.—Prof. Dewar, President, in the chair.—It was announced that the following changes in the Officers and Council were proposed by the Council. As

Vice-Presidents, Profs. Liveing and J. M. Thomson, *vice* Mr. L. Mond and Prof. Roberts-Austen; as Hon. Secretary, Dr. W. P. Wynne, *vice* Prof. J. M. Thomson; as ordinary Members of Council, Messrs. E. J. Bevan, H. J. Fenton, W. Gowland and D. Howard, *vice* Messrs. B. H. Brough, J. W. Rodger, T. K. Rose, and Prof. S. Young. The following papers were read:—Observations on the influence of the silent discharge of electricity on common air, by W. A. Shenstone and W. T. Evans. Air, when exposed to the action of the silent discharge, first contracts considerably and then expands to nearly its original volume; this is thus explained. Up to a certain stage in the ozonisation of atmospheric oxygen, no nitric peroxide is formed, but after this point is reached, nitric peroxide is produced, and ozone is rapidly decomposed by the silent discharge in presence of nitric peroxide, which is itself at the same time destroyed.—Some lecture experiments, by J. T. Cundall. The author describes lecture experiments illustrating the laws of conservation of mass and of gaseous diffusion.—Note on the preparation and properties of *o*-chlorobromobenzene, by J. J. Dobbie and F. Marsden. Orthochlorobromobenzene is a straw-coloured liquid boiling at 204° under 765 mm. pressure.—The ultra-violet absorption spectra of some closed chain carbon compounds, by W. N. Hartley and J. J. Dobbie. The absorption of ultra-violet rays by diketohexamethylene, pyrrol, thiophene, furfurane, furfurol, pyromucic acid and furfuramide has been examined; the absorption is in some cases very intense, but no absorption bands indicating selective absorption are observed.—Note on the absorption bands in the spectrum of benzene, by W. N. Hartley and J. J. Dobbie.—A chemical examination of the constituents of Indian and American podophyllum, by W. R. Dunstan and T. A. Henry. The constituents of Indian podophyllum (*Podophyllum emodi*) and of American podophyllum (*P. peltatum*) are identical; the chief constituent is podophyllotoxin, $C_{15}H_{14}O_6$; the latter on hydration yields podophyllic acid $C_{15}H_{16}O_7$, which forms a lactone, picropodophyllin, which is probably the hydroxycarboxylic acid of dimethoxymethylphenyl-hydro-γ-pyrone. An uncrystallisable resin, podophylloresin, was also isolated.—The volatile constituents of the wood of *Goupia tomentosa*, by W. R. Dunstan and T. A. Henry.—On oxycannabin from Indian hemp, by W. R. Dunstan and T. A. Henry.—On the condensation of formaldehyde with ethylic malonate and on cis- and trans- tetramethylenedicarboxylic acids (1:3), by E. W. Haworth and W. H. Perkin, jun. The condensation of formaldehyde with ethylic malonate in presence of acetic anhydride yields, in addition to ethylic propanetetracarboxylate, ethylic methylenemalonate and ethylic tetramethylenetetracarboxylate; one of the fractions on hydrolysis and elimination of carbon dioxide yields hexahydrotrimesic acid.—Formation of ethylic dihydroxydinicotinate from ethylic cyanacetate, by S. Ruhemann and K. C. Browning.

Linnean Society, February 3.—Dr. A. Günther, F.R.S., President, in the chair.—Prof. Stewart, F.R.S., exhibited (1) specimens illustrative of the articulation between the upper and lower jaw of a Skate, *Raia batis*, Linn., upon which remarks were made by Prof. Howes and Mr. Holt; and (2) sections of *Puccinia graminis* showing the form of the teleutospores and æcidiospores, upon which some observations were made by Dr. D. H. Scott, F.R.S., confirmatory of the exhibitor's views.—Mr. Thomas Christy exhibited a portion of an iron chain through the links of which a Virginian Creeper had grown, and had become naturally intertwined.—Mr. G. C Crick read a paper on the muscular attachment of the animal to its shell in some fossil Cephalopoda (*Ammonoidea*). Having first briefly noticed previous descriptions and figures of what were believed to be impressions of the muscular attachment of the Ammonoid animal to its shell, the author pointed out the form and position of the "shell-muscles" and of the "annulus" in the recent *Nautilus*, and indicated the form of the impression of these structures as seen upon an artificial internal cast of its body-chamber for comparison with the fossil forms, in nearly all of which any indication of the muscular attachment there may be is similarly preserved upon the internal cast of that chamber. Dr. H. Woodward, F.R.S., and Mr. B. B. Woodward offered some critical remarks.—Mr. W. C. Worsdell read a paper on the comparative anatomy of certain genera of the *Cycadaceæ*. In conclusion the author endeavoured to show that certain characters in the vegetative structure of these plants showed them to be nearly allied to, or descended from, certain fossil fern-like plants, notably the Medulloseæ, and these characters were: the extrafascicular zones in the stem of *Cycas*, which really represent the outer portion of the flattened concentric strands in the stem of the Medulloseæ, the inner portion of which has died out; and various concentric structures mentioned in the paper. For the type of structure prevailing in the ancestors of the Cycads would have been the concentric, whereas in their descendants it is the collateral. The significant outcome of this study is to form, in the vegetative characters of these plants, a connecting-link, over and above that already afforded by the discovery of spermatozoids in *Cycas* and *Ginkgo*, between "flowering" and "flowerless" plants. Dr. D. H. Scott, F.R.S., in criticising the paper, referred to the importance of certain facts which had been elucidated by the author and which he himself was able to confirm.

Anthropological Institute, February 22.—Mr. F. W. Rudler, President, in the chair.—The Rev. H. N. Hutchinson was elected a member.—Mr. Edge Partington exhibited representations of two tattooed Maori heads, carved in Kawrie resin.—Mr. Cantrill, of the Geological Survey, exhibited a collection of objects, including a delicately-worked flint dagger or knife, obtained during his recent exploration of a cairn in Breconshire.—The Rev. Archibald E. Hunt, of the London Missionary Society, read a paper on the natives of the Murray Islands in Torres Strait, with whom he had lived for three years. His studies had been directed along the lines indicated by the volume of ethnological notes and queries issued by the Anthropological Institute.—Prof. A. C. Haddon exhibited and explained a large series of lantern slides illustrative of the natives described by Mr. Hunt.

CAMBRIDGE.

Philosophical Society, February 7.—Mr. F. Darwin, President, in the chair.—Some zoological results of an expedition to Melanesia during the years 1894–97 (illustrated with photographic slides), by Dr. A. Willey, the Balfour Student. The paper dealt chiefly with observations relating to *Nautilus*, *Ctenoplana*, *Heteroplana*, *Amphioxus*, *Balanoglossus* and *Peripatus*. An account was given of the habits, distribution, and oviposition of *Nautilus*. The function of the tentacular appendages of *Nautilus*, the ciliation of the osphradia or branchial sense-organs and of the accessory olfactory (pre-ocular and post-ocular) tentacles, and the distribution of the pallial, siphuncular, and genital arteries were described. In the metameric system of *Nautilus*, where there are indications of two segments, at least twelve paired structures are repeated. The sheathed tentacular appendages of *Nautilus* and the arms of Dibranchiata are probably to be regarded as pedal in nature and origin, not only on account of their function, innervation and development (Dibranchiata), but also from a general consideration of the phenomena of cephalisation. The "cephalopodium" of *Nautilus* and the Dibranchiata was contrasted with the cephalothorax of Arthropods. *Ctenoplana* is probably to be estimated as a morphological type hardly second in importance to such forms as *Amphioxus*, *Balanoglossus*, *Peripatus*, &c. It presents a transition from biradial to bilateral symmetry. Its pinnate tentacles, like those of the Ctenophora, lie in what corresponds to the sagittal plane of the bilaterally symmetrical Plathelminthes, and are therefore not homologous with the sensory nuchal tentacles of Polyclades as was suggested by Lang. The latter structures are represented in *Ctenoplana* by the aboral ciliated sensory tentacles which are paired about the axis along which the pinnate tentacles lie; and in the Ctenophora by the arcuate sensory ridges and papillæ (Beroidæ) known as the polar plates, which are similarly placed with regard to the aboral sense-organ. *Heteroplana* was described as an anomalous Plathelminth in which the structures of the left side of the body are aborted. This condition appears to be normal for the animal, and not a phase in regeneration. *Amphioxus* was referred to in connection with the discovery of the West Indian subgenus *Asymmetron* Andrews in New Guinea waters, and also at Lifu (Loyalty Islands). The author's view that *Ptychodera* was a relatively primitive type of *Balanoglossus* was confirmed by the structure of his new genus *Spengelia*, which is a *Glandiceps*-like form possessing synapticula or cross-bars in the walls of the branchial sac, medial gonads, and vestigial roots arising from the collar nerve-cord. A new *Peripatus* found in New Britain was described. This form differs essentially from the groups which comprise respectively the Neotropical, Australasian and Cape species of *Peripatus*, and in some respects it is intermediate between the Australasian and Neotropical types.

MANCHESTER.

Literary and Philosophical Society, February 22.—Mr. J. Cosmo Melvill, President, in the chair.—The President announced that Prof. Michael Foster, F.R.S., would deliver the Wilde Lecture before the Society on March 29.—Mr. Melvill exhibited an interesting series of distortions and hypertrophical deformities of *Planorbis spirorbis*, L., found by Mr. Arthur Stubbs at Black Rock, Tenby. These distortions included (1) evolute whorls, (2) various forms of carination, (3) sinistral turbinate spirals, and (4) dextral turbinate spirals. The causes for such malformations are at present practically unknown, but may be traced to the obstructions to the active but tender-shelled mollusc caused by duckweed and conferva.

DUBLIN.

Royal Dublin Society, January 19.—The Right Rev. Monsignor Molloy in the chair.—Prof. Thomas Preston gave an account of some further observations which he had made in studying the influence of a strong magnetic field on the spectrum of a source of light placed in it. He exhibited photographs by lantern projection, which illustrated the different types of effect, showing that doublets, quartets and sextets are produced, as well as triplets when the source of light is viewed *across* the lines of force. The consideration of these modifications of the normal triplet type was entered into, and it was shown how such modifications could be produced by various forms of reversal accompanying absorption in the vapour of the spark which was the source of light. The connection of these modifications with the complexity of structure of some of the spectral lines, as observed by Michelson, was also passed in review, as well as further matters concerning the influence of the field itself on the molecules.—A paper, consisting of notes on certain Actiniaria (including *Phellia Sollasi*, Haddon) by Dr. Katherine Maguire, was communicated by Prof. A. C. Haddon, who also exhibited a phonograph, cinematograph, and other apparatus to be used in his projected expedition to New Guinea and Borneo.

EDINBURGH.

Mathematical Society, February 11.—Mr. J. B. Clark, President, in the chair.—Mr. Duthie read a paper on a geometrical problem, by S. Guimarães.—A proposal that, in the teaching of elementary geometry, Euclid's definition of proportion be abandoned, was introduced by Prof. Gibson and Mr. W. J. Macdonald, and discussed by several of the members present.

PARIS.

Academy of Sciences, February 21.—M. Wolf in the chair.—Chemical actions exerted by the silent discharge, by M. Berthelot. A preliminary account of the methods employed and general results obtained in the exposure of various mixtures to the action of the silent discharge. In all, more than a hundred and twenty systems were studied, the products being examined at various stages of each reaction.—Chemical actions caused by the silent discharge upon organic compounds. Gaseous systems. Hydrocarbons and nitrogen, by M. Berthelot. The action of the discharge upon the pure hydrocarbons was first studied. Marsh gas gave at first a little acetylene, which afterwards disappeared. After twenty-four hours the remaining gas was practically hydrogen, only five per cent. of the methane being unchanged. With nitrogen, absorption takes place with the formation of basic substances. Detailed results are also given for ethane, ethylene, acetylene, prophylene, trimethylene, and allylene, both alone and mixed with nitrogen.—On derivatives of cinchonine, by M. E. Grimaux. Several derivatives are described of the brominated substance obtained by adding bromine to the crude oxidation product of cinchonine according to the method of Kœnigs and Comstock.—On the place of the sponges in classification, and on the signification attributed to the embryonic leaflets, by M. Edmond Perrier. A criticism of a note on the same subject by M. Delage.—On iteration, by M. C. Bourlet.—Remarks on a note by M. Moreau on cycles of magnetic torsion and the residual torsion of soft iron, by M. H. Bouasse. The two laws announced by M. Moreau on residual torsion can be easily deduced from known facts.—On an analogy between the action of luminous rays and of lines of magnetic force, by M. Birkeland. A Crookes' tube is placed above an electromagnet, and is so arranged that the distance of the kathode from the magnet can be exactly regulated. Beyond a certain distance, the discharge in the tube is uninfluenced by the magnet, but as the tube gradually approaches there is a certain critical position at which all the properties of the discharge are suddenly changed, the difference of potential between the kathode and anode being reduced to a tenth of the original value, and the kathode rays are replaced by others which produce no phosphorescence in the tube. The critical distance increases with the strength of the magnetising current.—On the preponderance of the mechanical action of convection currents in the production of effluvia figures upon fogged plates submitted to the action of thermic poles in developing baths, by M. A. Guébhard.—On a combination of phosphoric anhydride with benzene, by M. H. Giran. The compound described is obtained by heating the two substances in a sealed tube at 120°. It is decomposed by water, and appears to be $C_6H_6 + 4P_2O_5$.—Influence of the X-rays upon the phenomenon of osmosis, by M. H. Bordier. The experiments show that in spite of the interposition of an aluminium plate in communication with the ground, osmosis is much slower when the apparatus is exposed to the X-rays.—Production of a mucinoid substance by bacteria, by MM. A. Charrin and A. Desgrez. A substance of an albuminoid nature is produced by the growth of the pyocyanic bacillus in beef broth. This possesses poisonous properties, a dose 0·15 grams per kilogram proving rapidly fatal to a rabbit. Other bacilli behave similarly.—On bitterness in wines, by MM. J. Bordas, Joulin, and Rackowski. A ferment has been isolated, to which the production of the bitterness in wine appears to be due.—On the aptitude of the spores of the truffle to germinate, and on the function of the aroma, by M. A. de Gramont de Lesparre. The aroma assists in the preservation of the species by its antiseptic action upon the spores.—On ktypeite, a new form of calcium carbonate, differing from both calcite and arragonite, by M. A. Lacroix.—The new form is found in the crystalline deposits of the thermal springs of Carlsbad and Hammam-Meskoutine. Heat transforms the mineral into calcite, with detonation.—Semolina and foods resembling vermicelli or macaroni, by M. Ballard. Analyses of semolina and macaroni from various sources. The quality appears to be in proportion to the amount of nitrogenous material.

NEW SOUTH WALES.

Royal Society, December 1, 1897.—The President, Henry Deane, in the chair.—On the steady flow of water in uniform pipes and channels, by G. H. Knibbs. The paper dealt generally with the nature of the two régimes under which flow takes place, and of the instability of the rectilinear flow in pipes. A general formula was proposed, to express the mean velocity of a flow of water in a circular pipe under either régime, at any temperature, and with any radius, "slope," or material of pipe.—Experimental investigation of the flow of water in uniform channels, by S. H. Barraclough and T. P. Strickland. The main object of this investigation was to fill in an hiatus in the existing series of experimental results, by determining the effect of change of slope upon the velocity of flow, when the slope is varied over a wide range.—Current Papers, No. 3, by H. C. Russell, C.M.G., F.R.S. This paper will be printed in vol. xxxii. of the Society's *Proceedings* for 1898.—Notes on Myrticolorin, by Henry G. Smith. In the abstract of proceedings for August 4, a paper by Mr. Smith is noticed wherein is announced a new dye-stuff obtained from the leaves of the "Red Stringy Bark," *Eucalyptus macrorhyncha*. This material, which in some respects is allied to aromadendrin, was stated to belong to the quercetin group of natural dyes. It was named by the author Myrticolorin, as it was supposed to be the only true dye substance obtained from the Myrtaceæ. This note amplifies previous statements by recording the results arrived at since the announcement above referred to. Myrticolorin is a glucoside of quercetin, and it breaks up on boiling with dilute sulphuric acid into quercetin and a sugar.—A second supplement to a Census of the Fauna of the Older Tertiary of Australia, by Prof. Ralph Tate, with an appendix on Corals, by John Dennant. Prof. Tate begins his paper by giving references to the principal contributions to Australian Tertiary Palæontology which have appeared since the publication of his first supplement in the *Journal* of this Society for 1888. He notes a number of genera hitherto unrecorded as being represented in Australia. In the Polyzoa, a synopsis is given of McGillivray's work, this author being almost entirely responsible for the very large additions to the genera and species of our Eocene fauna. Mr. Dennant's appendix is prefaced by a brief *résumé* of recent work on Australian Tertiary Corals. He then proceeds to record two hitherto unrecorded genera for the Australian Tertiary Corals.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (mathematico-physical section), part 3 (1897), contains the following scientific papers communicated to the Society:—

May 29.—E. Wiechert: The distribution of matter in the interior of the globe.

October 30.—W. Wirtinger: Green's function for a region bounded by non-intersecting spherical *continua* of *n* dimensions. K. Hensel: Determination of the discriminants of an algebraical *corpus*. K. Hensel: The fundamental equation and the non-essential discriminant-divisors of an algebraical *corpus*.

November 13.—W. Voigt: Further contributions to the kinetic theory of the process of evaporation.

November 27.—A. Hurwitz: The coefficients of development of the lemniscate-functions. G. Landsberg: On modular systems of the second grade and rings of numbers. O. Wallach: Researches from the Göttingen University Chemical Laboratory—(1) Cisisomerism and transisomerism in the menthol series; (2) ketones ($C_{10}H_{16}O$) from terpinene-nitrite; (3) reduction-products of carvone and eucarvone; (4) a new isomeric camphor from pinene; (5) on pulegenic acid; (6) new compounds from methylhexanone; (7) on fenchone-derivatives.

The official section, part 2 (1897), gives the text of an anniversary address by Dr. F. Merkel, on "the forces which mould the forms of animal bodies," and a report on a journey through Colombia and Venezuela by Prof. O. Bürger.

DIARY OF SOCIETIES.

THURSDAY, March 3.

Royal Society, at 4.30.—The Relationship of Variations of the Ground Water Level to the Incidence of Malarial Fevers in Chotta Nagpur. Bengal: Dr. L. Rogers.—On the Depletion of the Endosperm of *Hordeum vulgare* during Germination: H. T. Brown, F.R.S., and F. Escombe.—On Apogamy and the Development of Sporangia upon Fern Prothalli: W. H. Lang and G. A. Clark.—Experimental Observations on the Early Degenerative Changes in the Sensory End Organs of Muscles: Dr. F. E. Batten.

Royal Institution, at 3.—Recent Researches in Magnetism and Diamagnetism: Prof. J. A. Fleming, F.R.S.

Linnean Society, at 8.—On the Sense Organs of the Lateral Line in certain Fishes: F. J. Cole.—On the Occurrence of *Carex helvola* in Britain: G. C. Druce.—On Arctic Spiders from Franz Josef Land: Rev. O. Pickard-Cambridge.

Chemical Society, at 8.—Note on the Preparation of Dry Hydrogen Cyanide and Carbon Monoxide: John Wade and Lawrence C. Ponting.—Production of some Nitro- and Amido-Oxylutidines: Dr. J. N. Collie, F.R.S., and T. Tickle.—Production of some Nitro- and Amido-Oxylutidines: Dr. J. N. Collie, F.R.S., and Miss L. Hall.—The Interaction of Magnesium and Solution of Copper Sulphate: Dr. E. Divers, F.R.S.

FRIDAY, March 4.

Royal Institution, at 9.—Some Recent Results of Physico-Chemical Inquiry: Prof. T. E. Thorpe, F.R.S.

MONDAY, March 7.

Society of Arts, at 8.—The Principles of Design in Form: Hugh Stannus.

Imperial Institute, at 8.30.—The Mineral and other Resources of Newfoundland: J. H. Collins.

Victoria Institute, at 4.30.—The Design of the Human Foot: Gerald Smith.

TUESDAY, March 8.

Royal Institution, at 3.—The Simplest Living Things: Prof. E. Ray Lankester, F.R.S.

Society of Arts, at 8.—The Making of a Stained Glass Window: Lewis Foreman Day.

Anthropological Institute, at 8.30.

Institution of Civil Engineers, at 8.—Papers to be further discussed: The Theory Design, and Practical Working of Alternate-Current Motors: Llewelyn B. Atkinson.—Dublin Electric Tramway: H. F. Parshall.—Paper to be read with a view to Discussion: Calcium Carbide and Acetylene: Henry Fowler.

Royal Horticultural Society.—Floral and Botanical Demonstration.

Royal Photographic Society, at 8.—The Passage of a few of the Salts used in Photography through Gelatine Septa: A. Haddon.

Royal Victoria Hall, at 8.30.—A Work of Faraday: Prof. Reinold.

WEDNESDAY, March 9.

Society of Arts, at 8.—Linde's Method of producing Extreme Cold and Liquefying Air: Prof. J. Ewing, F.R.S.

Geological Society, at 8.—Note on Clipperton Atoll: Rear-Admiral Sir W. J. Wharton, K.C.B., F.R.S.—A Phosphatised Trachyte from Clipperton Atoll: J. J. H. Teall, F.R.S.—The Pliocene Deposits of the East of England. Part I. The Lenham Beds and the Coralline Crag: F. W. Harmer.

THURSDAY, March 10.

Royal Society, at 4.30.

Royal Institution, at 3.—Recent Researches on Magnetism and Diamagnetism: Prof. J. A. Fleming, F.R.S.

Society of Arts (Indian Section), at 4.30.—India and Sir Henry Maine: Charles Lewis Tupper, C.S.I.

Mathematical Society, at 8.—The Geodesic Geometry of Surfaces in non-Euclidean Space: A. N. Whitehead.—The Transformation of Linear Partial Differential Operators by Extended Linear Continuous Groups: Prof. Elliott, F.R.S.—Stereographic Illustrations of Catenaries: Prof. Greenhill, F.R.S., and T. I. Dewar.

Institution of Electrical Engineers, at 8.—On the Manufacture of Lamps and other Apparatus for 200 volt Circuits: G. Binswanger-Byng.

FRIDAY, March 11.

Royal Institution, at 9.—Marked Unexplored: W. F. Lord.

Royal Astronomical Society, at 8.

Institution of Civil Engineers, at 8.—The Drainage of Cottage Property: H. C. Adams.

Malacological Society, at 8.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

Books.—General Report on Public Instruction in the North-West Provinces and Oudh, 1896–97 (Allahabad).—Who's Who, 1898 (Black).—First Year of Scientific Knowledge: P. Bert, revised edition (Relfe).—The Wealth and Progress of New South Wales, 1895–96: T. A. Coghlan, Vol. 2 (Sydney, Gullick).—Das Weltgebäude: Dr. M. W. Meyer (Leipzig, Bibliographisches Institut).—Universal Electrical Directory, 1898 (Alabaster).—The Miner's Arithmetic and Mensuration: H. Davies (Chapman).—A Sketch of the Natural History (Vertebrates) of the British Islands: F. G. Aflalo (Blackwood).—Semitic Influence in Hellenic Mythology: R. Brown, jun. (Williams).—A Description of Minerals of Commercial Value: D. M. Barringer (Chapman).—Report on the Economic Resources of the West Indies: Dr. D. Morris (Eyre).—The *Electrician* Electrical Trades' Directory and Handbook for 1898 (*Electrician* Office).—Der Tägliche Wärmeumsatz im Boden und Die Wärmestrahlung Zwischen Himmel und Erde: Dr. T. Homén (Leipzig, Engelmann).—The Chemistry of the Garden: H. H. Cousins (Macmillan).—Note-Book of Agricultural Facts and Figures for Farmers and Farm-Students: P. McConnell, 6th edition (Lockwood).—Notes from a Diary, 1873–1881: Sir M. E. Grant Duff, 2 Vols. (Murray).—Report of Observations of Injurious Insects and Common Farm Pests: E. A. Ormerod, 21st Report (Simpkin).—Grundzüge der Geographisch-Morphologischen Methode der Pflanzensystematik: Dr. R. v. Wettstein (Jena, Fischer). The Naturalist's Directory, 1898 (Gill).

Pamphlet.—La Teoria dei Raggi Roentgen: Prof. Filippo Re (Palermo, Reber)).

Serials.—American Naturalist, January (Boston, Ginn).—Himmel und Erde, February (Berlin, Paetel).—Bulletin of the American Mathematical Society. February (New York, Macmillan).—Natural History Transactions of Northumberland, Durham, and Newcastle-on-Tyne, Vol. xiii. Part 2 (Williams).—Longman's Magazine. March (Longmans).—Good Words, March (Isbister).—Sunday Magazine. March (Isbister).—Humanitarian, March (Hutchinson).—Chambers's Journal, March (Chambers).—Botanische Jahrbücher, Vierundzwanzigster Band, iv. Heft (Leipzig).—Natural Science, March (Dent).—Contemporary Review, March (Isbister).—Century Magazine, March (Macmillan).

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THURSDAY, MARCH 10, 1898.

TWO TEXT-BOOKS OF ELEMENTARY GEOMETRY.

Geometry for Beginners. By G. M. Minchin, M.A., F.R.S. Pp. xii + 102. (Oxford: at the Clarendon Press, 1898.)

Euclid's Elements of Geometry, Books I. and II. Edited for the use of Schools, by Charles Smith, M.A., and Sophie Bryant, D.Sc. Pp. viii + 160. (London: Macmillan and Co., Ltd., 1897.)

THE appearance of these two little books shows that practical teachers have not yet agreed upon the best method of teaching elementary geometry. That this should be so is by no means a matter for regret; in the course of the controversy each party learns something from the criticism of the other; examination papers tend to become less stereotyped, and better adapted to test the student's real knowledge of the subject; while an intelligent teacher is more and more able to assert his right of freedom in giving geometrical instruction according to the method which, after a fair trial, he finds to be most efficient.

Prof. Minchin's book is a very favourable specimen of the methods of the reforming party. It is really what it professes to be, a book for beginners; it is obviously the result of long experience, and there is no reason to be surprised at the author's statement that the book has been used with boys of eight years with very great success. A very welcome feature, which might be adopted by all writers of introductory text-books, is the description of the graduated scale, the compass, the protractor, and set-squares, and of the way in which they are used. Parallel rulers are also described; it would have been well, in our opinion, to add that, while much may be learnt by handling a pair of parallel rulers, they are of little use for practical purposes, and that, generally speaking, set-squares should be used for drawing parallels. It is probably an oversight that the use of set-squares for drawing perpendiculars has not been explained. We thoroughly agree with Prof. Minchin in the opinion that the careful construction of figures, by means of the proper instruments, should be insisted upon for the sake of training the eye and hand of the pupil; and it may be added, that this exercise invariably helps to maintain a boy's interest in the problem or theorem upon which he happens to be engaged.

The choice of propositions is very judicious; they include the congruence of triangles, the elementary theory of parallels, exclusive of the so-called "axiom," properties of parallelograms, easy theorems about areas, and the theorem of Pythagoras. Besides this there are a few miscellaneous propositions, as, for instance, that the angle in a semicircle is a right angle. Definitions, we are glad to see, are introduced when they are wanted, and not before; and when necessary they are clearly explained and illustrated. The exercises are simple and well-chosen: it would be easy to add to their number and variety, and this would be an advantage to the book.

Of course there are some points which provoke criticism; but in offering any remarks upon them it is necessary to bear in mind the intention of the author; thus, for instance, however much the orthodox may protest, we think it is quite legitimate to define a straight line as the shortest distance between two points; on the other hand, it seems to us that the statement "a point is the smallest dot that can be made or imagined" is distinctly misleading, and that it is quite possible to give a more accurate idea of what is meant. Then again there is no objection, at this stage, to saying that a plane is a perfectly flat surface: but the top of a table, a school-slate, or the surface of water in a basin is a better illustration than a sheet of paper. It would also be a good thing to point out the reverse order of procedure, where a surface appears as the boundary of a solid, a line as that of a surface, and a point as that of a line, or the crossing of two lines. A playing ball painted in different colours makes a good illustration; so does a cube, a ruler, or a piece of india-rubber of the ordinary shape.

In some cases only one figure has been given where there ought to have been two or more: for example, in propositions L, S and T; and in the problem on p. 79 it might be pointed out that R may be on either side of PQ, but that the construction fails if we take PR equal to PO, and try to put R on the same side as O.

In cases where circles are used in the construction of figures, it is properly observed that it is not always necessary to draw the complete circles. We would go a little further than this, and in the later propositions, at any rate, introduce in the figures quite small arcs, such as those made by a practical draughtsman; this might be done, for instance, on pp. 78, 79. As the student is supposed to use a pencil compass, there would be four small arcs to indicate on p. 79.

It would be a great mistake to overload a work of this kind; still it might be thought worth while, and would not be inconsistent with the plan of the book, to give the construction for dividing a line into a given number of equal parts, and that for reducing a rectilineal polygon to a rectangle of equal area. The construction of a regular hexagon and a regular octagon might perhaps be included, either as propositions or examples; and it would be well to add some examples, say, of plotting quadrilateral or pentagonal fields from given data, or of drawing such figures as, for instance, a square with an outward semicircle on each side of it as diameter.

These suggestions are made in the confident hope that there will soon be a demand for another edition of Prof. Minchin's excellent little book. In the hands of a competent teacher it cannot fail to be successful; and it will do much, we hope, to convince the average parent and schoolmaster that geometry is not dull mechanical drudgery, and that its principles and results may be comprehended by means of ordinary common-sense. Its adoption as an introductory course will not hinder, but greatly help, a more rigorous study of the subject afterwards; even the most questionable part of the book, the sham proof (for such it is) of the sum of the angles of a triangle being equal to two right angles, need not be a permanent stumbling-block in the pupil's way.

The edition of Euclid's first two books by Mr. C.

Smith and Mrs. Bryant is of the moderately conservative type, preserving Euclid's order of propositions, but admitting, especially in Book II., some simplifications of construction and proof. It is not easy to see any definite advantages of this edition over others already in the market; and in some respects it is certainly inferior. The figures are poor; not a few awkward for the pupil to draw, *e.g.* those on pp. 76, 100; and some are grossly inaccurate, such as those on pp. 80, 122. Then, considering the authors' evident desire for strict logic and accurate statement, some of their *obiter dicta* are really surprising. Thus we are told that "the *unequal* side of an isosceles triangle is generally called the base"; that I. 44 is "sometimes enunciated in the form, 'Construct a parallelogram equal to a given parallelogram, and having one of its sides of given length'"; and that I. 17 is equivalent to "If a straight line intersects two other straight lines which meet in a point, the two interior angles which it makes with those straight lines are together less than two right angles." Not to mention the fact that the three lines may be concurrent, the interior angles referred to ought to have been specified.

The bad plan is followed of placing all the definitions, axioms, and postulates at the beginning; a wrong definition of *postulate* is given so as to confine it to postulates of construction, and the postulate required for the theory of parallels appears in its time-honoured, but non-Euclidean place as an axiom. The authors are of opinion that axiom 9 ("magnitudes which can be made to coincide are equal") is Euclid's definition of the equality of geometrical magnitudes, and ought to be put first, and then the other axioms 1—7 can be proved by superposition. In this we feel sure they are mistaken. The real meaning of axiom 9 is that magnitudes which can be made to coincide are *equal* in a sense consistent with the term as used in the preceding axioms; thus, for instance, if a figure A can be made to coincide with a figure B, and if another figure C can be made to coincide with B, then A and C can be made to coincide. That Euclid does not imply the congruence of equal magnitudes is obvious from I. 35, &c. It is true that either of the parallelograms in I. 35 may be cut up into pieces which may be fitted together so as to make up the other parallelogram; but this fact does not appear in Euclid's proof, and it is doubtful whether he was aware of it. And it is clear that "equal" cannot mean simply "congruent," because if congruent figures are taken from congruent figures the remainders are not necessarily congruent.

This brings us to the statement (p. 66), "Whenever there is equality of area" of two figures, "one of the figures can theoretically be divided into parts which, when properly fitted together, will coincide with the other figure." If "parts" means "a finite number of parts," we should like to know the proof of this assertion: it cannot be true in any sense except for figures drawn upon surfaces which are applicable to each other. To take a very simple case, can it be verified for three circles whose diameters are the sides of a right-angled triangle?[1]

In the alternative proof of II. 12, no reason whatever is given for the equality of the rectangles AY, AZ, so that the whole difficulty of this method of proof is shirked by means of a "similarly" applied to dissimilars; the same imperfection occurs in the alternative proof of II. 13.

In I. 24, figures to illustrate the different cases ought surely to have been given; and we should have thought that the direct proof, by superposition, of the first case of I. 26 might have been admitted as an alternative.

Twenty-six abbreviations have been adopted; the definite article is expressed or omitted according to some mystical principle which we have been unable to discover; in some cases the construction and proof are kept separate, and duly labelled in Clarendon type accordingly, in others they are mixed up.

We confess that, on the whole, the perusal of this book has had a depressing effect; it is like reading a treatise on apologetics, and finding that it leaves you more inclined to be sceptical than before. The most serious objection made against text-books of the more modern type is that young boys fail to really grip the essential parts of some of the proofs, and thus, though they understand them at the time, reproduce them in an imperfect and slipshod manner. But here we have two editors of the orthodox text-book, brought up themselves, no doubt, in the true Euclidean faith, and with scores of school editions from which to take warning and example, who nevertheless are by no means above reproach, in grammar, logic, or precision of statement.

Erroneous methods of teaching elementary geometry are still so prevalent, and teachers are so apt to rely entirely on their text-book, that every treatise, Euclidean or not, which is intended for beginners, should contain a description of simple instruments and their use, and some hints on the proper way of learning the propositions. Before a teacher sets a proposition to be learnt he should, with a class of beginners, go through it with a blackboard explaining every point, and in particular every technical term when it first occurs; he should insist upon the data of the figure, and these only, being first drawn, and the rest put in as the steps of the construction are stated (this should also be done, at first, by the pupil when learning the proposition); and he should, from the outset, avoid using the same letters as those in the book. This, and the early introduction of very simple exercises, will ensure that the pupil uses his brains and not merely his memory; unless this is the case, the study of geometry is about as improving as it would be to learn by heart a page of the London Directory.

G. B. M.

[1] Unless the arguments of Réthy (*Math. Ann.* xxxviii.) are unsound, this question must be answered in the negative.

OUR BOOK SHELF.

Whittaker's Mechanical Engineer's Pocket-Book. By Philip R. Björling. Pp. 377 + viii. (London: Whittaker and Co., 1898.)

A GOOD pocket-book is a necessity to the engineer; it supplies him with reference tables and constants for facilitating calculations, and also the experience of other engineers in a condensed and handy form for use. One feature of this work is that a rather larger share than usual is given to hydraulics and hydraulic machinery, and also to mining plant. In the formula on p. 3, for the discharge over weirs, a too small coefficient of discharge (apparently 0·45 only) has been adopted; there is also a misprint in the first line of the second column on p. 7, it should be 8·025. In the formula on p. 55, for friction of the leather collars of rams, it is not stated

in what units the answer is obtained; presumably it is in pounds. The one section which is very disappointing is that devoted to gas engines; only three pages are given to them, and one of these is filled with a useless description of the two original types—the Lenoir and Otto and Langen, both of course interesting in an historical account of the origin of the gas engine, but not of the slightest value or claim to notice in a pocket-book: in future editions it is to be hoped more attention will be given to this section, and that the page mentioned will be cut out. The author would have done well to make use of the recent determination of the mechanical equivalent of heat; most engineers are now adopting 778 as the figure. On p. 93 occurs an awkward misprint in the formula for mean pressure of steam; the letter in the denominator should be R, and not P, as printed. The rules given for the cooling surface of surface condensers, on p. 113, must apply only to single-cylinder engines; at any rate, they give areas greater than usually adopted in the best modern practice for triple compound plants. The sections devoted to pipes and gearing are admirable, and there are many most useful tables; the last fifty or sixty pages contain a valuable collection of tables of weights of various sections of iron and steel, areas of circles, cubes, square roots, &c. We have pointed out a few blemishes, but the book as a whole is very free from slips or errors, and will be, no doubt, of service to many engineers, draughtsmen, and works-managers. H. B.

Handbooks of Practical Science. No. I. *Mensuration, Hydrostatics and Heat.* Pp. 53. No II. *Chemical Experiments.* Pp. 58. By G. H. Wyatt, B.Sc., A.R.C.Sc. (London: Rivingtons, 1897, 1898.)

Science Handbooks for Laboratory and Class Room: Elementary Physics, Practical and Theoretical. First Year's Course. By John G. Kerr, M.A. Pp. 140. (London: Blackie and Son, 1898.)

Quantitative Practical Chemistry. Part I. Elementary Stage. Pp. 55. Part II. Advanced Stage. Pp. 31. By A. H. Mitchell, B.Sc. (Reading: National Publishing Association, Ltd., 1897.)

A NUMBER of simple and instructive experiments are described by Mr. Wyatt in the practical handbooks referred to above. Following sound educational principles the student is told what to do, but so far as it is practicable he is left to find out for himself the conclusions to be drawn from the experiments. In this respect the books are constructed upon the lines of others which are already in use in schools where elementary science is taught. A few practical exercises are given on the principles brought out by the experiments; but the teacher will find it necessary to considerably increase the number of these, if he wishes his pupils to remember what they have done. In his shorthand manuals Sir Isaac Pitman used to advise the students who wished to become proficient in the art of phonography to "Practice, Practice, Practice," and the same advice applies to instruction in elementary science. Not one or two, but twenty or thirty experiments are, for instance, necessary before young students can thoroughly understand the significance of the principle of Archimedes. The difficulty in the way of carrying out so much experimental work is one of time, and if a large amount of work has to be accomplished in a short time, the depth of knowledge is thinner in proportion to the area covered.

In the first of Mr. Wyatt's handbooks, the usual elementary exercises in mensuration, hydrostatics and heat are given; while the second contains simple experiments on general chemical processes, air, combustion, carbon, various common substances, such as salt, lime, &c., acids, alkalis, hydrogen, water, chalk, and important gases. Too much ground is covered in the latter volume for the work to give satisfactory results, but taken as a whole the handbook will be found very serviceable in teaching the rudiments of science.

Mr. Kerr's book on elementary practical physics has much to commend it, and deserves to be widely adopted by pupils commencing the study of physical science. The book contains about a school year's work of three or four hours per week. In the first half a number of experiments to be performed by the pupils individually are described, and in the second half the chapters are more of a descriptive nature, so that they provide material for the pupil to study and wherewith the teacher may exercise him. The principles of measurement, and simple laws of mechanics, form the subjects of the experiments, and the author has introduced many ingenious methods into his work. The pupil who carries out the experiments will be given knowledge which he is not likely to forget. Moreover, as the experiments are mostly quantitative, they offer a valuable course of training for the mind.

Ability to perform simple quantitative experiments is now required by the Department of Science and Art from students of both the elementary and advanced stages of practical chemistry. The object of Mr. Mitchell's slender volumes is to supplement existing text-books by exercises bearing upon the new requirements. Part I. contains experiments on measurement of length, volume, specific gravity and common chemical changes, and Part II. is concerned with the experiments in volumetric analysis so far as they are required of students in the advanced stage.

Researches on Tuberculosis. The Weber-Parkes Prize Essay, 1897. By Arthur Ransome, M.A., M.D. (Cantab), F.R.S., Consulting Physician to the Manchester Hospital for Consumption, &c.

THE book before us is the reprint of an essay written in accordance with certain specific regulations framed by the Royal College of Physicians. This diminishes to some extent the general value of the book, as it almost confines its contents to the individual experience and results of the author. These latter are, however, very extensive, and almost all ground of interest in this subject is to some extent covered. A lengthy chapter is devoted to the natural history of the tubercle bacillus, another to preventive and prophylactic measures; channels and sources of infection are also fully considered. The book concludes with a chapter upon the direct treatment of phthisis. In this connection it may be mentioned that the author seems to have obtained very satisfactory results from the inhalation of ozone. We are pleased that the Royal College of Physicians gave its consent to the publication of this essay, as the book will no doubt be of considerable interest to those engaged in researches upon this subject. F. W. T.

"*The Electrician*" *Electrical Trades' Directory and Handbook for* 1898. (Sixteenth Year). Pp. 918 + cxliii. (London: *The Electrician* Printing and Publishing Co., Ltd., 1898.)

The Universal Electrical Directory (*J. A. Berly's*). Pp. 1182. (London: H. Alabaster, Gatehouse, and Co., 1898.)

THESE two ponderous volumes give evidence of the remarkable growth of the electrical and allied industries during the past few years. Two large sheets, folded in the first of the volumes at the head of this notice, give particulars of the present electric supply works of the United Kingdom, and the electric railways and tramways. Very few of the supply stations were in existence at the beginning of 1890, and if the progress is as great in the next eight years as it has been in the past eight years, few districts will be without electricity for light, power and traction purposes. The biographical division of the Directory is of more than professional interest, as it contains short sketches of the careers of many

physical investigators, accompanied by numerous pleasing portraits. A steel-plate portrait of Mr. J. W. Swann heads this section.

The second Directory contains "a complete record of all the industries directly or indirectly connected with electricity and magnetism, and the names and addresses of manufacturers in Great Britain, India, the Colonies, America, the Continent, &c." Every means has been taken to facilitate reference, and to make the Directory of service to all who are concerned with electrical industries.

A Flower Hunter in Queensland and New Zealand. By Mrs. Rowan. Pp. xiii + 272. (London: Murray, 1898.)

THIS book is one to be laid down with regret, so brightly does the authoress tell of very varied scenes and experiences, and so easily is the reader carried along with her through them. There are few books of travels in which the fascination of the tropics to a naturalist is so evident, or that would more strongly arouse the desire to see for oneself what is here so well described. But the other side of the shield is no less vividly placed before the reader, and the price at which alone the pleasures of tropical travel can be bought can be well realised from it. Old travellers will find their experiences recalled, and will bear witness to the accuracy of Mrs. Rowan's descriptions alike of the beauties and of the discomforts of the tropics, and will recognise that the latter are expressed in no overstrained terms. There are many interesting references to the earlier history of the Colonies, and others, equally interesting, to points in natural history, though in a few of the latter the want of technical knowledge shows itself. Many and wonderful as are the powers of ants, observed in and authenticated from all parts of the world, we should have hesitated to believe about the nests of the green ants of Queensland, that "leaves and flowers are spun together by spiders that the ants keep for the purpose." Mr. Saville-Kent's statement that he has observed the ants use their own full-fed larvæ to supply the silk required for spinning the leaves together, affords an explanation sufficiently curious, but more in accordance with what we should expect. Numerous excellent views add to the attractiveness of the volume. It deserves, and will doubtless receive, a welcome from those interested in travels and natural history.

Introduction to Chemical Methods of Clinical Diagnosis. By D. H. Tappeiner (Munich). Translated from the sixth German edition, with an appendix on micro-biological methods of diagnosis, by Edmond I. McWeeney, M.A., M.D. (Roy. Univ. of Ireland), Professor of Pathology and Bacteriology C.U. Med. Sch., &c. Pp. vii + 152. Figs. 22. (London: Longmans, Green, and Co., 1898.)

THE little book before us consists of two parts—the first, chemical; the second, what the author calls micro-biological. The term micro-biological is an accurate one, and includes the usual bacteriological work on the one hand, and the examination of blood corpuscles and the morphological elements of the secretions on the other. Any system of classification—and one must have some—has its disadvantages: the present one seems to work very well.

The book is well up to date, serum diagnosis and the chemical examination of the gastric contents being contained in it. We think under the chemistry of the urine a method for the quantitative estimation of urea and uric acid ought to have been included. As far as we are aware, there is no book in English of such small bulk which contains so complete an account of chemical and bacteriological or microbiological diagnostic methods. It will not, of course, compete with the larger books on this subject, as, for instance, von Jaksch, but will doubtless have a sale, and deserves it. F. W. T.

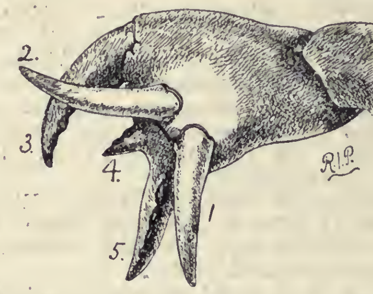
LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Five-fingered Crab.

DURING a recent visit to the museum at Dover, I noticed in the case allotted to the Crustacea a remarkable instance of malformation affecting the right pincer of a half-grown specimen of our common edible crab (*Cancer pagurus*); and not recollecting to have seen the like either figured or described, I venture to think the publication of the subjoined sketch, together with a few words of explanation, may prove of interest to the readers of NATURE.

A glance at this sketch will show that there are three complete subequal movable fingers or dactylopodites, numbered 1, 2, 3. Of these, number 3 clearly corresponds to the single movable finger of the normal pincer, numbers 1 and 2 being supernumerary and articulated close together upon an elevation of the hand (propodite), which is much thickened in this region. The two remaining fingers (indices) are immovable. Number 4 is very much the shorter of the two, number 5 being quite comparable in size to either of the three movable digits. Judging from its size and the spot whence it emerges from the hand, the larger index (5) represents the immovable finger of the normal pincer; but its toothed edge is directed, not towards the normal finger (3), but towards the supernumerary finger (1). The smaller index finger (4), on the contrary, has its biting margin turned towards the biting margin of the normal movable finger



(3), and in all respects, except size and point of origin, corresponds exactly to the immovable finger of the normal pincer. When the movable digits are closed, number 1 passes on the under side of 5, number 2 on the upper side of 3, and number 3 shuts directly upon 4.

I am only acquainted with records of two cases of malformation in crabs' claws resembling this specimen in the Dover Museum. One of these is figured and described by Mr. Bateson (*Materials for the Study of Variation*, p. 530, No. 815; also *Proc. Zool. Soc.*, 1890, p. 581); the other by M. Sénéchal (*Bull. Soc. Zool. France*, 1888, p. 123). In the former, however, the supernumerary movable fingers numbered 1 and 2 in the figure of the Dover specimen are represented by a single dactylopodite, which, nevertheless, shows its double nature by being divided at the tip and furnished with two rows of teeth along its biting edge. In the example observed by Sénéchal, on the contrary, there are three complete movable digits arranged apparently very much as in the specimen here described and figured; but the process from the propodite (hand) is represented by a broad plate consisting of three only partially separated indices.

February 27. R. I. POCOCK.

Dew and Absorption.

I AM engaged on some daily experiments with a view to measure dew as rain in lineal inches. At present, however, I cannot distinguish between dew and absorption.

I fill a small cylinder (A) of tinned iron—a tobacco canister—to within about 1 inch of the top with garden soil, dry it at 212° F., weigh, expose it over-night, and re-weigh at 9 a.m. before the sun comes on it.

I now purpose to expose another similar tin (B) with ten circular holes pierced near its rim, and covered with a horizontal glass plate.

I hope that B may give some measure of *absorption*, and A—B some measure of *dew*.

I reckon grammes of weight gained as cubic centimetres of water, divide this number by the number of sq. cm. in the circular opening, and take the quotient thus obtained as the measure in linear cm. of dew as rain.

I shall be greatly obliged if any readers can refer me to previous experiments that have been made in this direction.

Harpenden. T. WILSON.

Oat Smut as an Artist's Pigment.

WITH regard to Prof. Marshall Ward's note under this heading (p. 389, *ante*), I may add that, according to Mr. K. Miyabe, the olive-brown spores of *Ustilago esculenta* ("Makomo-zumi" in Japanese), besides its application to the painting of the ladies' eyebrows in Japan, are mixed up with oil and smeared on the scalp and hairs by older women who have the hairs thin or grey. "At present," the author adds, "the spores are largely used in the lacquer industry to produce rusty-coloured wares by mixing them with lac" (*The Botanical Magazine*, Tôkyô, vol. ix. p. 197, May 1895).

KUMAGUSU MINAKATA.

February 25.

GEOLOGICAL PHOTOGRAPHS.

THE Committee appointed by the British Association for the collection and safeguarding of photographs of geological interest has a good record of work to show for the past year. The entire collection of 1750 prints is now uniformly mounted and deposited in the library of the Museum of Practical Geology at Jermyn Street. Over 350 new prints were received during last year. A new feature has been the formation of a collection of picked duplicates illustrating typical geological phenomena which, in the form of prints or lantern slides, can be lent to local scientific societies or others desiring either to know what work the Committee is doing, or to help on the work.

No less than 119 of the new photographs come from Ireland, and the north of that country is now well illustrated. As is well known, the geology of this region is exceptionally interesting as it was the site of a great volcanic outburst in Tertiary times, and the columnar lavas and sills, the dykes intrusive into chalk and into newer and older rocks, the laccolites, volcanic necks and ash beds, form a text-book of volcanic geology. One of the most remarkable localities is Cave Hill, near Belfast, where the unconformable junction of the chalk with the lavas has been well exposed by the quarrying operations.

The remarkable section shown in the annexed figure (Fig. 1) is reproduced from an excellent photograph by Mr. R. Welch, of Belfast. Unfortunately the section is now being destroyed by quarrying, so that this photograph is the best record we possess of it. It shows an old, steep, pre-Tertiary cliff of chalk which was gradually buried in débris, most of which was derived from itself. Both cliff and débris were buried by basaltic lavas and ash beds thrown out by the volcanoes which broke out along great fissures in early Eocene times.

Photographed by Mr. R. Welch, Belfast.] [*Copyright.*

FIG. 1.—Cave Hill, Belfast.

Glacial phenomena admit admirably of registration by photography, and the collection is fairly rich in such illustrations.

Although Ramsay many years ago wrote an account of the glaciation of North Wales, comparatively little connected work has been since done to elucidate this remarkable example of upland glaciation, while a complete photographic record of it remains to be executed. Some few points have, however, been dealt with, notably by the late J. J. Cole, Messrs. Williamson and Wills, Mr. Godfrey Bingley, Mr. Atchison and others, and their work is in the collection. Good as it is, however, it serves best to show how much in the way of systematic recording there is still left to be done. Some one should set to work with Ramsay's book in his hand, visit the localities mentioned, photograph them, and, guided by it, seek out and record a complete account of the glaciation of the entire region; and he cannot do better than begin on Snowdon. Just opposite Snowdon, on a small hill, Y Foel Perfedd, above Pen-y Pass Hotel, the perched block shown in Mr. Bingley's photograph (Fig. 2), of which a reproduction is annexed, overhangs the Pass of

Llanberis, and looks as if a mere touch would precipitate it into the Pass below.

Photographs have often been taken of single examples of fossil trees in submerged forests and in the coal-measures or other rocks. But it is not often that a whole forest of Carboniferous trees is exposed to-day in quarrying operations, and it is still more rare to have them preserved for future generations by a building, as has been done in the instance from Partick, figured below. This photograph was taken by Mr. R. McF. Mure, of Paisley, who has kindly furnished me with particulars as to the size of the trees: the stems are most of them over two feet in diameter at the base, and the spread of the roots in some cases is correspondingly large.

W. W. WATTS.

Photographed by Mr. G. Bingley, Headingley, Leeds.] *[Copyright.*

FIG. 2.—Y Foel, Perfedd, Llanberis.

Photographed by Mr. R. McF. Mure, Paisley.] *[Copyright.*

FIG. 3.—Carboniferous Forest, Partick, Glasgow.

SOME RARE BIRDS' EGGS.

ON comparing the numerous works which have appeared of late years on British birds with their predecessors of a couple of decades or more ago, we cannot fail to be struck with the great diminution in the number of species whose eggs and nests are stated to be unknown. And since the appearance of even the more recent of these, one more gap has been filled up by the announcement of the discovery by Mr. Popham, last July, on an island in the mouth of the Yenisei, of the long-sought eggs of the curlew-sandpiper (*Tringa subarquata*). By this fortunate discovery the number of species entitled, even by the utmost stretch of courtesy, to be included in the British list whose eggs still remain unknown, is very small indeed, although there are several species of which the known specimens are extremely few. Of course there are a host of foreign birds whose nidification awaits discovery, but to mention even a portion of these would obviously be impossible within the limits of an ordinary article. The majority of the British species whose breeding haunts offered the longest resistance to the efforts of egg-hunters, were those which migrate at this season to the desolate Arctic tundras; and among the eager explorers of the avifauna of those regions the name of John Wolley will always stand pre-eminent, ably as his pioneer efforts have been seconded and completed by men of the stamp of the late Mr. H. Seebohm and Colonel Feilden, to say nothing of many equally enthusiastic and capable observers. At the present day one of the great fields remaining for exploration are the breeding areas of many of the species inhabiting the southern hemisphere.

In many respects birds' eggs have proved a somewhat disappointing study, since, if we except their aid in bringing about the recognition of the intimate structural affinities existing between the Limicolæ and the Gaviæ, they have afforded comparatively little assistance in unravelling the tangled skein of avian relationships. And many of the generalisations which have been drawn from them, such as those relating to white eggs, have turned out to be true only in part. Moreover, it is unlikely that those remaining to be discovered will add anything really important to our stock of knowledge. The newly-discovered eggs of the curlew-sandpiper, for example, do not differ from those of the allied forms in any more important degree than do the different postage-stamps of the same issue.

Not that the quest of birds' eggs is in any way to be discouraged—far from it. While the eggs themselves, from the intrinsic beauty of their shape and coloration, form a never-ending source of delight to the collector, it is only through the energy of the hunter after these spoils that a knowledge of the habits of the birds themselves can ever be attained. In the words of Prof. A. Newton, it is the field naturalist who alone crowns the

labours of the anatomist and the museum-worker. "What engineer," writes the Professor, "can be said to understand his business if he knows not the purpose to which the machines he makes are to be applied, and is unacquainted with their mode of working. We may investigate thoroughly the organs of any animal, we may trace them from the earliest moment in which they become defined, and watch them as they develop to maturity, we may comprehend the way in which every part of a complicated structure is built up; but if we take not the trouble to know their effects on the economy of the creature, we as naturalists have done but half our task, and abandon our labour when the fulness of reward is coming upon us." All honour then to those (if only they work in the right way) who risk their health, if not their lives, and spend their treasure, in the quest of the rarer birds' eggs!

Although they have been removed from the list of desiderata, the eggs of the curlew-sandpiper will probably long remain among the rarest of those of the British species, those from the Yenisei being the only specimens at present known. Among the species included in the British lists whose eggs were unknown at least as late as 1896, is Pallas's grey shrike (*Lanius sibiricus*), but as this bird is so closely allied to the ordinary species, their discovery cannot be looked forward to with any special interest. The second is the needle-tailed swift (*Chætura caudacuta*), which has only twice been seen in Britain, and breeds in northern Asia, although its eggs are still unknown. Equally slight are the claims of the sharp-tailed sandpiper (*Tringa acuminuta*) to be regarded as British; and, although still unknown, its eggs will probably prove very similar to those of the American *T. maculata*. To the rare and beautiful wedge-tailed gull (*Rhodostethia rosea*), reported to have been once seen in Britain, is provisionally assigned a single egg in the British Museum obtained from Disco Bay. Of far more interest would be the discovery of the eggs of the Cape petrel (*Daption capensis*), since this bird, of which an example was killed in Dublin in 1881, represents a genus by itself. One of its breeding-places appears to be Kerguelen Island. Of two other petrels, namely *Œstrelata hæsitata* and *Œ. brevipes*, with equally slight claims to admission in the British lists, the eggs are likewise unknown.

Of species whose eggs are known, although of extreme rarity, next to the curlew-sandpiper, the white-billed diver (*Colymbus adamsi*), a by no means very rare visitor to our coasts, may first claim attention. The only known eggs, which are very like those of the great northern diver, were obtained during the voyage of the *Vega* in 1879. Of the lovely ivory gull (*Pagophila eburnea*) the eggs have been described by Prof. Collett; while those of the Iceland gull (*Larus leucopterus*) and Mediterranean black-backed gull (*L. melanocephalus*) come also under the category of rarities, the nest of the latter species being unknown. Of greater interest are the beautiful eggs of the Sandwich tern, of which additional specimens were recorded last year. Although obtained by Wolley, the eggs of the spotted redshank (*Totanus fuscus*) must be regarded as prizes by the collector; while so late as 1893 those of the solitary sandpiper (*T. solitarius*) were recorded by Mr. Dixon as unknown, although one clutch has been described by Mr. Elliot, in which the eggs resembled those of the piping sand-plover. Claim to a place in this section is undoubtedly held by the sanderling, of which eggs were obtained by MacFarlane in Arctic America in 1863, and subsequently by Colonel Feilden in Grinnell-land. The knot (*Tringa canutus*) is another of the species which appears in Mr. Dixon's book of 1893 as among those of which the eggs are unknown. It seems, however, that a clutch of four was taken in Greenland as far back as 1875, one of which is now in the British Museum; and these, with a single specimen taken from the body of a female by Lieut. Greeley, appear to be the only examples in collections. Far less uncommon are the eggs of the little stint (*T. minuta*), although they still come under the category of rarities, as do those of the jack snipe, which were first taken by Wolley in Lapland. The crestless lapwing (*Vanellus gregarius*), of which but one British specimen is on record, is also a bird of whose nidification details are wanting, although the eggs are known to be four in number, and very similar to those of the crested species. Dotterel eggs, although very handsome, can now scarcely be considered as rarities; but those of the lesser golden plover (*Charadrius dominicus*) are very scarce, although their similarity to those of the ordinary species renders them less interesting than would otherwise be the case.

Passing other members of the foregoing groups whose eggs are more or less scarce, allusion must specially be made to the common bernicle goose, of which it is a remarkable fact that eggs laid in a wild state are quite unknown, although this is somewhat discounted by the circumstance that birds have nested in captivity. Of the nearly allied red-breasted bernicle (*Bernicla ruficollis*) the eggs have, however, been discovered, and, except for their somewhat smaller dimensions, are stated to be indistinguishable from those of the bean-goose.

Although the eggs of all the species of birds of prey recorded as British are known, some are comparatively rare in collections. Among such may be mentioned those of the red-footed kestrel (*Falco vespertinus*), which although not uncommonly taken in Russia, were so poorly represented in the British Museum in 1896 that Dr. Bowdler Sharpe stated he was unable to properly define their characters.

In addition to those of Pallas's shrike, which have already been mentioned in the unknown list, the following are some of the rarer eggs among the British Passerines. From their beautiful markings the eggs of all the buntings are always favourites with collectors; and from their rarity those of the rustic bunting must be specially prized. Two only are in the Seebohm collection in the British Museum, although others have been described by Mr. Dresser, and yet others are mentioned by Prof. Newton as among the specialities of last year's collecting. Richard's pipit (*Anthus richardi*) affords an example of a bird of which the eggs are known, but the nest has never been described. Among comparative rarities the eggs of the yellow-browed willow-warbler (*Phylloscopus superciliaris*) and the marsh-warbler (*Acrocephalus palustris*) deserve passing mention, especially as many referred to the latter species appear to be nothing more than pale examples of the reed-warbler. Perhaps the greatest prizes among the British representatives of the group are, however, the eggs of White's thrush (*Turdus varius*). A nest, with eggs, from Ningpo attributed to this species is included in the Seebohm collection, and undoubted specimens are mentioned in Prof. Newton's list of new acquisitions. Less rare are the eggs of the black-throated ouzel (*T. atrigularis*), of which several clutches have been taken in the Altai, although the nest is still unknown. Another desideratum is the nest of the Siberian ground-thrush (*T. sibiricus*), of the eggs of which three specimens taken in Japan, and now in the Seebohm collection, were the only examples known up to 1896. Of the Arctic bluethroat (*Cyanecula suecica*) the eggs, which resemble those of a redwing in miniature, are far less rare, but must still be reckoned as among the collector's choicest treasures.

To go further into the British list would be beyond the limits of this article, while, as already said, species not occurring in that list must be excluded. An exception may, however, be made in favour of the rare Pander's chough-thrush (*Podoces panderi*), of the deserts of Central

Asia. Of this bird the eggs were first obtained, we believe, by Fedtchenko, and have ever since ranked as great rarities, and collectors will therefore be interested in finding specimens included among those collected last year and mentioned by Prof. Newton. R. L.

NOTES.

THE Council of the Royal Society have invited Dr. Wilhelm Pfeffer, professor of botany in the University of Leipzig, and foreign member of the Royal Society, to deliver the Croonian Lecture on March 17. The subject of the lecture is to be "On the Nature and Significance of Functional Metabolism (*Betriebs-stoffwechsels*) in the Plant." The lecture will be delivered in German. Prof. Pfeffer is well known among botanists for his two volumes on "Pflanzenphysiologie," published in 1881 from Tübingen, and the second edition of which was issued last year; while his views on the function of chlorophyll, and its absorption-spectrum, are familiar to workers on the physiology of plant-life.

MORE than 100 foreign zoologists have now consented to be members of the "Committee of Patronage" of the Fourth International Congress of Zoology, and a large number of them have expressed the hope that they will be able to be present at the meeting in August next. Among these we may mention the names of Prof. Häckel, of Jena; Prof. Graff, of Graz; Prof. Grassi, of Rome; M. Blanchard, of Paris; Baron Jules de Guerne, who has been associated with the Prince of Monaco; Dr. Jentink, of Leyden, who was President of the Third Congress; Dr. Dollo, of Brussels; and Prof. Collett, of Christiania. From the United States it is hoped there will be a somewhat large contingent; Profs. Osborn and Scott, Prof. E. B. Wilson, and Mr. Watasé, of Chicago, all hope to be able to come.

THE sixth "James Forrest" Lecture of the Institution of Civil Engineers will be delivered on Thursday, March 17, at eight o'clock. Prof. W. Boyd Dawkins, F.R.S., the lecturer, takes for his subject "Geology in relation to Engineering."

THE Mayor of Bradford presided at a meeting, held on Monday, for the purpose of considering a proposal to invite the British Association to Bradford for the year 1900. It was unanimously decided to send an invitation to the Association for the year 1900, and an executive committee was appointed to make arrangements if the invitation should be accepted.

IT is expected that some of the observers of the recent total eclipse of the sun will give a preliminary account of their observations at the meeting of the Royal Astronomical Society to-morrow.

THE Municipal Council of Paris have inserted in the budget for this year the sum of ten thousand francs, for the laboratory of photography and radiography at the Salpêtrière.

THE following grants have recently been made by the Trustees of the Elizabeth Thompson Science Fund:—250 dollars to Prof. Gustav Hüfner (Tübingen), for the investigation of hæmin and hæmatine; 288 dollars to Prof. Carlo Bonacini (Modena), for researches in colour photography; 250 dollars to Prof. John Milne, to aid in a seismic survey of the world.

THE Zürich correspondent of the *Times* states that the observatory on Mont Blanc, which was constructed by M. Joseph Vallot some seven years ago, is to be transferred to another site. The present structure is built on a small rocky plateau, which extends for a short distance from the Rochers des Bosses, but its position is no longer favourable for scientific observations. The construction of the building has served as a barrier against which the snow piles itself in ever-increasing masses, causing both trouble and expense to the observatory staff. The whole erection is to be transferred, piece by piece, on the backs of workmen from the Rochers des Bosses to a rocky point at the same altitude, where the ground will first be levelled by blasting, and, in spite of the difficulties of climate and transport attending these operations, it is hoped that the whole transfer will be finished in the course of one summer season.

AT the meeting of the Entomological Society of London on March 2, a discussion took place on the reported introduction of the San José scale, *Aspidiotus perniciosus*, into Great Britain. Mr. R. Newstead, the only British entomologist who is now specially occupied with Coccidæ, stated that during the past nine years he had never once met with this species among the numerous scale-insects taken in this country and forwarded to him for identification. It was impossible even for an expert to distinguish it, without careful microscopical preparation and examination, from among the thirty or more described species of *Aspidiotus*, and any attempt to identify it on imported fruit by naked-eye observation, or with a hand-lens, was therefore quite impracticable. The risk of its distribution by importation on fruit was small; there was, however, much more likelihood of its introduction on plants or trees. At the same time he saw no reason to suppose that it would be more injurious in this country than the common *Mytilaspis pomorum*; in America the San José scale had several, sometimes as many as five, generations in the year, but in this climate it would probably conform with the habits of all other scale-insects at present investigated and become single-brooded. Mr. Newstead's conclusions were generally agreed with by the Fellows present.

ACCORDING to the *Bulletin de la Société Française de Physique*, M. Crémieu has devised an ingenious means of producing elliptic sound-vibrations in air. By the interference of the longitudinal vibrations of two organ-pipes, placed at right angles, and vibrating under the influence of two diapasons with the proper difference of phase, an elliptic motion was set up at the intersection of the tubes, and its existence was made evident by means of delicate quartz fibres which followed all the movements of the air.

M. A. LEDUC, in a paper read before the Société Française de Physique, criticises the well-known law of mixture of gases, according to which the pressure of a mixture is the sum of the pressures of its constituents at the same volume and temperature. This law is only true for perfect gases, and is then equivalent to the statement that the volume of the mixture equals the sum of the volumes of its constituents at the same pressure and temperature. From experiments on several gas-mixtures, M. Leduc considers that the second form of the law is rigorously applicable to certain mixtures of real gases, and is, in general, in closer approximation with experiment than the first.

IN the *Annales du Bureau Central Meteorologique*, M. Moureaux gives an account of the different comparisons he has made between the magnetic instruments of the Parc Saint Maur Observatory and those of the observatories at Kew, Uccle (Brussels) and Pavlovsk (St. Petersbourg). The comparison observations made at Kew have already been described by Mr. Chree in a communication to the Royal Society. The declination at Pavlovsk was found to be 1'·3 higher than the French standard, the horizontal force 0·00013 lower, and the dip 0'·8 lower. At Uccle the declination was 1'·5 lower, the horizontal force 0·00002 lower, and the dip was not compared. In the account of the Kew comparisons an arithmetical error occurs which makes the horizontal force difference 0·00011 when it ought to be 0·00012.

IN connection with recent measurements of the temperature of the air at high altitudes, Signor Luigi de Marchi, writing in the *Rendiconto del R. Istituto Lombardo*, discusses the validity of Mendeléef's and Herschel's laws connecting temperature with altitude, and draws conclusions which may be briefly summed up thus:—(*a*) Recent measurements of temperature of the higher strata of the atmosphere can be represented by a formula of the type of Mendeléef's, viz. $t + C = (T + C)p/P$, where, however, C increases with the altitude; (*b*) for altitudes below about 4500 metres the formula agrees with observation when C is taken as a linear function of the altitude, but for greater altitudes, up to 13,000 metres, the supposition that C is a linear function of the pressure gives the best results, the formula then reducing, like Herschel's, to an equation of the second degree in p; (*c*) for altitudes of a few thousand metres Mendeléef's formula gives sufficiently approximate results when C is taken to be constant; (*d*) the validity of the proposed formula, if substantiated by further observations, would confirm the hypothesis that the temperature of a stratum at any given altitude is determined principally by the equilibrium between the thermal radiations which it receives from the ground, and which it emits into the sky, when the assumed law of radiation is that of Newton or of Stefan. The latter law in the strata hitherto reached would lead to a formula less reconcilable with the data of observation than the former.

ONE of the difficulties which water-engineers have to face is the unpleasant odour which sometimes characterises surface waters stored in open reservoirs. Such odours are frequently supposed to be due to the decomposition of organic matter in the water, but, although such may be the case, in many instances they have been found to be attributable to the growth of microscopical organisms, and quite a long list has now been furnished of vegetable growths which impart disagreeable tastes and smells to water. Messrs. Jackson and Ellms have just published a memoir describing their investigations upon one of the *Cyanophyceæ* or blue-green Algæ which, when growing in water, impregnates the latter with a most unpleasant mouldy grassy smell. Pure cultures of *Anabæna circinalis*, an important offender in this particular, were obtained and numerous experiments were carried out. As in the case of other microscopical water-organisms, the odour emitted during growth was found to be due to the presence of certain compounds of the nature of essential oils which make their appearance at a particular stage of growth. The investigation was also extended to an examination of these Anabæna during decay, a most offensive odour being given off during decomposition. This the writers think is probably due to the high percentages of nitrogen which these growths contain. The gas given off during decomposition was analysed and was found to contain a large percentage of hydrogen, and a considerable proportion of sulphur compounds. Analyses of the decayed gelatinous material resulting from the decomposition of Anabæna revealed the presence of a large amount of sulphur and a considerable amount of phosphorus. The subject is of such importance in connection with the storage of surface waters, that the closer study of the chemical composition of these organisms and of the organic and mineral contents of the waters which the various genera infest, is well worthy of attention; for by extending our knowledge in this manner, we should be better able to judge beforehand of the likelihood of particular waters becoming subject to these unpleasant changes on storage. The above memoir is to be found in vol. x. of the *Technology Quarterly*, Massachusetts.

THE receipt by the University of Pennsylvania of a collection of mammalian fossils from the tundra at the back of Point Barrow, Alaska, has induced Mr. S. N. Rhoads to put together the available information on the living and extinct species of North American *Boves*. Mr. Rhoads refers one of the Alaskan Bison-heads to an unnamed species which he proposes to call *Bison alaskensis* (*Proc. Ac. N.S. Phil.*, 1897, p. 490). He has likewise taken this opportunity to examine the question of the so-called "Woodland Bison" of the Peace-River district of Athabasca. It appears that an adult male specimen of this little-known animal has recently been obtained by the Geological Museum of Ottawa. Mr. Rhoads describes this example from information sent to him by Prof. J. Macoun, and refers it to a new sub-species, *Bison bison athabascæ*, separating it from the typical form on account of its "great size, darkness of colour, and the characters of the horns and horn-cores."

AN interesting article on the wild cattle of Chartley, Staffordshire, is contributed to *Nature Notes* by Mr. J. R. B. Masefield. This herd of wild white cattle is of great antiquity; but whether the present animals are directly descended from some one of the ancient native species, such as *Bos primigenius*, *Bos longifrons*, &c., or whether they are descendants of domestic cattle introduced by the Romans and run wild, is still an undecided question. The home of these cattle is situated on high ground some 300 feet above sea-level, and was enclosed about the year 1200, and forms a portion of Chartley Park, some five miles from Uttoxeter, the nearest town. The extent of this wild tract of table-land is about 1000 acres, covered with coarse grass, rushes, stunted bilberries, and heather, and patches of luxuriant bracken fern, with a few clumps of old weather-beaten Scotch firs and birch, which afford some shade from the hot summer sun. Among the other denizens of this wild primeval tract are herds of red and fallow deer and multitudes of rabbits, (with no doubt a few of their natural enemies, the stoat and voles—both the common vole and red bank vole), moles, long-tailed field mice, shrews, weasels, and adders. The theory that the Chartley breed of wild cattle is indigenous appears to be supported by their general habits at the present day. When alarmed they start off at full gallop for a short distance, then turn and face their foe in a semicircle, with the bulls in front, the cows behind, and the younger animals and calves still further in the rear. If closer approached, these tactics, which are clearly those of wild animals, are repeated, or the adversary is charged and attacked. Again, they conceal their young in fern or long rushes, and the cows, when calves are born, become exceedingly fierce and dangerous, especially if an intruder should get between a cow and her calf. Mr. Masefield points out that a fine herd of white cattle, very strongly resembling the Chartley breed, are to be found at Lamphey Court, near Tenby, in South Wales; they are said to belong to an old Welsh breed, but in colour and general appearance it is difficult to distinguish them from the Chartley animals.

M. P. VUILLOT has completed a map of the lake districts of Timbuktu on the scale of 1/100,000, which contains a number of topographical discoveries in this little-known region. In presenting the map to the Paris Geographical Society, M. Vuillot adds an interesting note on the hydrography of the area, and on its productiveness, which has been published in the Society's *Comptes rendus*.

PROF. THEOBALD FISCHER contributes a short paper to *Petermann's Mittheilungen* on the "moraine-amphitheatre" of the Lake of Garda. The form of the moraine deposits on the inner or Italian side of the Alps differs markedly in type from that on the outer or German side. In the former type, of which the Lake of Garda affords an excellent example, the deposits are laid down in concentric ramparts which turn their convex side to the plains; while in the latter we find the familiar expanded fan shape at the mouths of the valleys. Dr. Fischer avails himself of the very excellent maps and models furnished by the Italian Service.

THE first two numbers of the new volume of the *Mittheilungen* of the Vienna Geographical Society are devoted to a memoir on the Hallstätter See, by Dr. Lorenz, Ritter von Liburnau, which extends to over 200 octavo pages. The form and position of the lake are discussed, chemical analyses are given of its waters and of the waters of the inflowing streams, and there are elaborate investigations into the distribution of temperature at different depths and at different seasons, into currents, transparency and colour of water, and the various forms of life. Dr. Lorenz had the assistance of a large number of colleagues in making his observations, and was fortunate in having a steam launch placed at his disposal free of cost.

Petermann's Mittheilungen contains an account of a recent expedition into the interior of Dutch East Borneo by Dr. A. W. Nieuwenhuis. The region between the upper basins of the Kapuas and the Kutei or Mahakam rivers was not visited by the Dutch expedition of 1894, owing to the supposed hostility of the natives; but by judicious treatment and selection of native companions, Dr. Nieuwenhuis has succeeded in exploring a considerable area. A stay of eight months was made at a station on the Bloeoe, a small right-bank tributary of the Mahakam, giving opportunity for detailed topographical and geological surveys. Extensive collections were made, which have reached Buitenzorg in safety.

IN descending the Niger, the Hourst Expedition found the navigation of that river impeded by rapids from Ansongo to below Boussa. As this was during the season of high water, M. le Lieut. de Chevigne was detailed in May 1897 to make a further reconnaissance when the river was at its lowest. The results of his observations are published in the *Comptes rendus* of the Paris Geographical Society, and are described as of special importance on account of a French station having been recently established at Say. The Niger is to be considered as navigable from Timbuktu to Ansongo, but only during high water; below Ansongo, rocky shallows and rapids render navigation difficult at all seasons, and dangerous, if not impossible, for nine months in the year.

IN the *Bulletin* of the Imperial Society of Naturalists of Moscow, No. 2 for 1897, is a lengthy and important paper (in German) by C. Sokolowa, on the growth of root-hairs and rhizoids. He appears to have come to the conclusion that neither the growth of the cell-wall nor the currents in the protoplasm are directly dependent on the cell-nucleus, although the position of the nucleus appears to a certain extent to determine the direction of the currents. N. Malischeff contributes some remarks on the nerve-endings in the œsophagus and stomach of birds. The remaining papers are in Russian.

DR. F. VON KERNER publishes a short account of some recent geological work on the coast regions of Dalmatia in the *Verhandlungen* of the Austrian Geological Survey. The peninsula of Ostrica, the island of Zlarin, and a number of the neighbouring rocky islets were surveyed, disclosing some features of geological and geographical interest. The islands together form part of the submerged lower course of the river Kerka.

AT the recent Ithaca meeting, the Association of American Anatomists adopted the report of the majority of the Committee on Anatomical Nomenclature, and ordered it to be published and distributed as soon as practicable, accompanied by the objections of the minority of the Committee, and comments thereon by the Secretary of the Committee. Of the neural terms recommended, more than 100 were identical with those adopted in 1895 by the Anatomische Gesellschaft.

WITH reference to our note on M. J. Deniker' papers on the characteristics of the inhabitants of the various districts of Europe (p. 351-2), the author writes to correct an error which unfortunately crept into his paper. In our note, p. 352, line 14, the race "(β) Blond, mesocephalic, very short," should be ascribed to Saxony-Poland instead of Sweden.

THE additions to the Zoological Society's Gardens during the past week include a Masked Paradoxure (*Paradoxure larratus*), a Large Indian Civet (*Viverra zibetha*) from Western Szechuen, China, presented by Mr. Julius Newmann; three Punjaub Wild Sheep (*Ovis vignei*, ♂ ♀ ♀) from Southern Persia, deposited; a Common Seal (*Shoca vitulina*) from Holland, an Indian River Snake (*Tropidonotus piscator*) from India, purchased; a Leopard (*Felis pardus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

OCCULTATION OF ANTARES.—The occultation of a star of the first magnitude is of rare occurrence, more especially when the moon is at such a favourable age as in the case of the occultation of Antares (α Scorpii) magnitude 1·1, on March 13, when the moon is in the last quarter. The times of disappearance at the bright edge and reappearance at the dark edge, as given in the *Nautical Almanac*, for Greenwich are 14h. 38m. 0s., and 15h. 49m. 0s; and the angles at which these respective phenomena take place are 111° and 305°, measured from the vertex. The occultation of this beautiful red star is a most interesting observation, especially at the favourable phase of the moon, which should render the doubling of Antares easily visible. It was during an occultation that Burg discovered the celebrated blue companion in 1819.

NAUTICAL ALMANAC, 1901.—The *Nautical Almanac* for the year 1901 has just been issued. It is arranged in a similar way to those now familiar to us, and from it we learn the details of the total eclipse of the sun which takes place in that year on May 17. The path of the shadow passes over Sumatra, Borneo, Celebes, and the southern part of New Guinea; the eclipse will also be visible in Australia, but only as a large partial one, whilst in Europe and America no trace of it can be observed. This eclipse is remarkable for being one in which the duration of totality is nearly the longest possible, the maximum obscuration of the sun lasting about six and a half minutes.

We notice also that in accordance with the decision of the Paris Conference on Fundamental Stars, held in May 1896, the constants of precession, nutation, aberration and solar parallax, as set forth at that meeting, have been adopted. The new value for the solar parallax is, therefore, 8″·80 instead of 8″·848, and this is probably correct to within 0″·02.

Part I. of the *Almanac* is issued separately, as of late years, and contains such information as is essential to navigators.

VARIABLE STAR U PEGASI.—In a recent issue of NATURE, p. 352, we noted Mr. O. C. Wendell's observations of the short-period variable, made at the Harvard College Observatory, and the results of which were issued by Prof. Pickering in Circular No. 23. In the *Astronomical Journal*, No. 426, Mr. Chandler brings data together to show that the light curve is, as was originally laid down, of single period, and not analogous to that of β Lyræ, with a small difference of 0·15 mag. between the primary and secondary minima. He also points out that the polarising photometer failed to make manifest the secondary minimum of the star Z Herculis, a phenomenon involving a difference of nearly 0·5 mag., or three times the amount in question.

In Circular No. 25 (on polarising photometers), Prof. Pickering points out that the objections to the first form of photometer have been remedied, and now the emergent pencils of the images compared coincide, and a surprising degree of accuracy may be obtained in the measures, which is illustrated by numbers from actual observations. He also gives the individual results derived from Mr. Wendell's observations, and these show that the largest value of the secondary minimum is 0·05 mag. less than the smallest value of the primary minimum. Besides this he shows that if the minima be assumed to be equal, the residuals at first minimum have a mean value of +0·064, and at the second the mean value is −0·070. He concludes that "the probability, therefore, that the two minima are really equal and that these deviations are due to accidental error is extremely small; and it is very singular that if these deviations are due to systematic error, that it has one value at principal minimum and another at secondary minimum."

THE PHOTOGRAPHY OF NEBULÆ.

PHOTOGRAPHY has been a helpful handmaid in many branches of astronomical science, but in no department is the value of her assistance more clearly seen than in that which is concerned with the forms and structures of nebulæ. This is hardly to be wondered at when the fine texture, the almost imperceptible gradations of light, the intricacy of detail, and the variety of nebulous forms are considered. Many vigils must be kept by an astronomer before the trend and comparative distinctness of a particular nebulous feature is satisfactorily observed; and even where this has been done, to represent the characteristic faithfully is beyond the power of any but the most accomplished draughtsmen. The unimaginative photographic plate, however, looks heavenwards for a few minutes and has imprinted upon it not only the delicate details which tease the eye of the observer and elude the skill of the artist, but also records a greater extent of celestial mist than the human eye is capable of grasping. On this account exceptional interest is attached to what has been accomplished in the portraiture of nebulæ, and the following survey of the subject will serve to show some of the roads along which progress has been made.

EARLY DAYS OF NEBULAR PHOTOGRAPHY.

Dr. Henry Draper was the pioneer of nebular photography; he succeeded in obtaining a photograph of the nebula of Orion on September 30, 1880. ("Washington Observations," vol. xxv., 1878. Appendix i. p. 226.) Only the brightest parts of the nebula were comprised within the picture; nevertheless, the result was such as to show that photography had great possibilities before it as a delineator of nebulæ. Encouraged by the tangible fruits of his labour, Dr. Draper took a number of photographs of Orion's nebula, and in March 1881 obtained a picture showing stars fainter than the fourteenth magnitude; that is, stars only just within the limits of visibility of the telescope employed in the work. This fact was not lost upon him, for in a short note communicated to the Paris Academy of Sciences in April 1881 (*Comptes rendus*, vol. xcii. p. 964, 1881), he remarked that astronomers might reasonably expect to photograph stars which were quite beyond the visual reach of the most perspicuous observer; in other words, that a sensitive plate at the eye-end of a telescope could see objects which were too faint to produce any impression upon the retina of an observer using the same instrument. The picture which led to this remark was taken with an exposure of 104 minutes. Towards the beginning of the following year, a fine negative was produced by exposing a gelatino-bromide plate to the nebula for 137 minutes. This photograph comprised more of the nebulous matter, and especially of the delicate outlying parts, than any of the previous ones. In commenting at the time upon the strikingly perfect representation of the nebula afforded by the picture ("Washington Observations," vol. xxv.; Appendix i. p. 227), Prof. E. S. Holden compared it with Bond's drawing of the same object. This observer spent several years scrutinising the nebula, and, as a result of his patient observation, was able to produce a picture which represented its features with greater accuracy and artistic effect than had previously been attained. Dr. Draper's photograph of the nebula was taken in a little over two hours, yet Prof. Holden confessed that for nearly every purpose it was incomparably better than Bond's hand-drawn picture. It was evident from this that a new epoch of nebular observation had been opened. Exact and automatic representations of nebulæ were to take the place of the strange, and often crude, drawings of these objects. The new method inaugurated by Dr. Draper has developed so much that, at the present time, it may almost be said that photography entirely holds the field as a nebula-artist.

A nebula rarely has a definite form, like the sun and moon. It presents the appearance of a cloud having more or less irregular outlines, and of which the various parts differ greatly in brightness. It results from this that photographs of the same nebula may be very different in appearance, for their characters depend upon the power of the telescope employed in their production, the time during which the sensitive plate was exposed, the sensitiveness of the plate, the transparency of the atmosphere, and many other causes. While Dr. Draper was working upon the Orion nebula in America, Dr. Janssen was experimenting at Meudon with a view of determining the influence of some of the variable conditions upon the results obtained (*Comptes rendus*, vol. xcii. p. 261, 1881). By taking photographs with exposures of five, ten, and fifteen minutes respectively, the eminent French investigator found that the longer the nebulous light was beating upon the sensitive film, the greater was the extent of nebulosity portrayed. It was this fact which permitted Dr. Draper to obtain his epoch-making picture, and has led to even more remarkable results during the past few years.

So long ago as 1874, Dr. A. A. Common was engaged in celestial photography, but it was not until May 1882 that he exhibited a photograph of the nebula in Orion (*Monthly Notices, R.A.S.*, vol. xliv. p. 222, 1883-84). The instrument used by him was a reflecting telescope three feet in diameter, specially constructed for photographic work. Such a large instrument is necessarily difficult to adjust and drive, and a laborious series of experiments had to be made before it could be said to be in working order. But the time spent in devising improvements was well repaid by the photograph of the Orion nebula taken by Dr. Common in January 1883. The photograph showed details of the nebula never before properly represented by the hand, and which can hardly be discerned by the eye. With the confidence that comes from experience, it was then predicted that "we are approaching a time when photography will give us the means of recording in its own inimitable way the shape of the nebula and the relative brightness of the different parts, in a better manner than the most careful hand-drawings."

This prophecy was strikingly fulfilled in less than three years after it was made.

THE PLEIADES NEBULA.

In the early part of the year 1885 a fine photographic telescope was added to the equipment of the Paris Observatory, and placed under the control of two brothers, MM. Paul and Prosper Henry. The instrument had only been mounted a few months when it was used to photograph a cluster of stars—the Pleiades—which has attracted attention from time immemorial. The picture obtained showed truthfully the relative positions and grandeurs of the stars in and near the beautiful bunch of lucid points to which the telescope had been directed. But it was not so much the imprints of hundreds of stars that made the picture interesting to astronomers, as the fact that a new nebula appeared upon it. Round "stately Maia"—a star just visible to the naked eye—several wisps of nebulosity were clearly portrayed. Three further photographs of the same celestial region confirmed the existence of this nebulous matter, though no trace of haziness had previously been detected by ordinary telescopic observation (*Monthly Notices, R.A.S.*, vol. xlvi. p. 98, 1885-86).

It is a remarkable fact, however, that when an object has been discovered an observer is frequently able to see it, though he may have passed it over many times in previous surveys. So it was with the nebula round Maia. Very shortly after the announcement of the discovery had been made, M. Struve turned the 30-inch refractor at Pulkova towards the star to which attention had been directed, and found that he could distinctly see the nebulous surroundings (*Comptes rendus*, vol. cii. p. 281, 1886).

But faint objects are not only overlooked by the observer while viewing celestial scenery through his "optic tube"; they often go undetected on photographs themselves. The announcement of the discovery of the nebula recalled to Prof. E. C. Pickering's mind that certain irregularities had been noticed in a photograph of the Pleiades taken at Harvard College Observatory on November 3, 1885 (*Astronomische Nachrichten*, vol. cxiii. p. 399, 1886), that is, thirteen days before the MM. Henry obtained their first photograph showing Maia's nebulous surroundings. A re-examination of the Harvard College picture confirmed his surmise that the markings, which had previously been passed over as blemishes, were really the wisps of nebulosity photographed at Paris. Extending the scrutiny to the remainder of the Pleiades, indications of nebulous light were found about Merope, and a strange narrow streak was seen projecting from Electra. The Paris photographs showed similar appendages to these stars. This was not, however, a new discovery; the nebula near Merope was seen by W. Tempel while observing at Venice as far back as 1859 (*ibid.*, vol. liv. p. 286, 1861), and though several astronomers unsuccessfully searched for the object, many illustrious observers had attested to its existence (*Monthly Notices, R.A.S.*, xl. p. 622, 1879-80). Photography established the reality of Tempel's observations; and what is more, it was soon able to show that the faint patch, which had been the subject of so much discussion, was but a bright part of a vast nebulosity, in which the clustering stars were immersed.

Dr. Isaac Roberts was the astronomer who brought to light

the wonderful extensions round the Pleiades. His work in celestial photography has been so fruitful in results, that a brief record of its growth will not be out of place. In 1883, Dr. Roberts made a series of experiments to test the suitability of ordinary photographic lenses for the delineation of celestial objects ("Photographs of Stars, Star-Clusters, and Nebula," I. Roberts, 1894). The results were so promising that he determined to develop the photographic method of observation, and, with this end in view, he ordered to be constructed a reflecting telescope of twenty inches diameter, and one hundred inches focal length. The instrument was ready for use in April 1885, and work was then commenced with it. But it was not until more than a year later that its performances began to reach Dr. Roberts's expectations. Only those who have had to coax astronomical instruments into a tractable condition, can understand and appreciate the difficulties with which he had to contend. It was found that satisfactory photographs could not be obtained until the driving-clock of the telescope had been greatly improved in regard to its ability to keep the instrument accurately following the apparent movements of the stars. When a sensitive plate has to be exposed to starlight for three or four hours, the beams from individual stars must continually beat upon the same spot, otherwise the stellar images do not appear as circular discs upon the resulting picture. To attain this desideratum—that is to say, to make a clock capable of driving a telescope so

Fig. 1.—The Pleiades Nebula. (From a photograph by Dr. Roberts, with an exposure of ten hours.)

as to keep absolutely the same time as the stars—taxes the instrument-maker to his utmost; and, when Dr. Roberts commenced his work, there was no controlling clock that completely supplied the want. His early photographs, therefore, did not exhibit the stars as perfectly circular spots, nevertheless they greatly extended the state of knowledge of the Pleiades nebulosities. In October 1886, the first of his remarkable long-exposure photographs was obtained, the sensitive plate being kept directed to the Pleiades for three hours. With regard to the amount of nebulosity shown, the resulting picture was far in advance of all previous ones. It demonstrated that the MM. Henry had merely picked up the fringe of the nebulous matter round the Pleiades, for not only were all the stars of the cluster shown to be shrouded in nebulæ, but, to quote Dr. Roberts's words (*Monthly Notices*, *R.A.S.*, vol. xlvii. p. 24, 1886-7), "the nebulosity extends in streamers and fleecy masses, till it seems almost to fill the spaces between the stars, and to extend far beyond them. It suggests the probability that these stars in the Pleiades, together with many of the stars around them, are involved either directly or else in slight alignment with one vast nebula." This surmise was more than justified by future results. A year after it was made, the Henrys succeeded in obtaining a photograph which confirmed it. They, like Dr. Roberts, had been working towards perfecting their new engine of research. By the use of more sensitive plates, and by increasing the duration of exposure, they were able to bear witness that the feeble traces of nebulosity shown around the stars Maia, Merope, and Electra, on the views taken two years previously, appeared on the new photographs as bright nebulous masses, all more or less merging into one another, while an extensive lucid patch surrounded Alcyone (Observatoire de Paris, *Rapport Annuel*, 1887). Threads of nebulosity were also revealed, projecting from the central mass and having stars strung upon them like beads on a rosary.

Until recently, the best result of Pleiades photography was reached by Dr. Roberts at the end of 1888 (*Monthly Notices, R.A.S.*, vol. xlix. p. 120, 1888-89). The view of the wonderful group then obtained was produced by exposing the sensitive plate for four hours. It showed more clearly and more beautifully the filmy sea in which the stars are immersed, but did not extend the limits defined by the earlier pictures. The *ne plus ultra* of Pleiades photography was lately obtained by Dr. Roberts with an exposure of ten hours, and a reproduction of the picture is here given (Fig. 1). No process of reproduction can, however, do justice to the brilliant picture which Dr. Roberts has permitted us to reproduce.

The epoch-making views of the Pleiades obtained ten years ago gave a great impetus to nebular photography. The thought that for a time to be reckoned in æons, the gauze-like veil on which the Pleiades were studded had been unable to affect man's visual perceptions, but could register its existence automatically upon a prepared surface, was sufficient to open up a vista of marvellous possibilities.

Dr. Roberts's photograph of the Pleiades nebula has become a classic. Of his numerous other photographs of nebulæ, three have attained a like eminence; they represent the Great Nebula in Orion (to which reference has previously been made), the Great Nebula in Andromeda, and the Spiral Nebula in the constellation of Canes Venatici, and to these attention must here be confined. It is perhaps invidious to select these pictures from the collection of five hundred photographs of nebulæ and clusters with which Dr. Roberts has enriched astronomy, for every one of his photographs adds to what was previously known about the objects portrayed. The nebulæ above designated, however, were all made to record their own forms at about the same time, and each of the monochromes produced exhibited striking novelties.

The Orion Nebula.

A photograph of the Orion nebula taken by Dr. Roberts in November 1887, though only representing a tentative result, showed nebulous matter covering an area quite seven times greater than that covered by Dr. Common's photograph (*Monthly Notices*, *R.A.S.*, vol. xlvii. p. 89).

What Dr. Roberts had gained in extent, however, he had lost in detail. The delicate structure of the central part of the nebula appeared but a splash of white upon the print presented to the Royal Astronomical Society, though it is fair to add that they could be distinguished upon the negative. The lesson learned was, that it was extremely difficult to obtain upon one and the same print a representation of the nebula showing it to the fullest extent, and also exhibiting the fine markings and imperceptible gradations that characterise such objects. An increase of the time of exposure certainly increases the area of nebulosity depicted upon a photographic plate; but while the picture is having its limits extended, the filmy rays in the brighter regions of nebulosity are being "burnt out" by the cumulative action. This difficulty has now been overcome; for since Dr. Roberts revealed to astronomers the vast extent of the Orion nebula, he has taken, upon a single plate, photographs which show the fine detail of the nebulous structure as well as the great sky-area covered by the nebulous mass. One of these pictures, taken with a dual exposure of seven hours thirty-five minutes, on two evenings in February 1894, is here reproduced (Fig. 2), and it represents, according to Dr. Roberts, "the maximum of extent and detail that can be shown by aid of photographic methods." The illustration is, however, but a feeble representation of the original picture. Longer exposure with a reflecting telescope, such as that used by Dr. Roberts, would result in the photographic plate being fogged by the general luminosity of the sky sufficiently to obscure dim nebulous streamers and faint stars. With a refracting telescope Dr. Gill has given an ex-

posure of nearly twenty-five hours to the nebulous region around Eta Argus, without the film of the photographic plate being much darkened, but the conditions with a refractor are not precisely similar to those which obtain in the case of a reflector having a short ratio of focal length to aperture.

It appears, however, from some photographs recently taken by Mr. W. E. Wilson, F.R.S., and exhibited at the Royal Astronomical Society, that the time of exposure needed by the photographic plate to depict the greater part of the Orion nebula may be considerably reduced. Mr. Wilson uses a reflecting telescope of twenty-four inches aperture, and ten feet six inches focal length, constructed by Sir Howard Grubb, and provided with his usual type of driving-clock and electrical control. With this instrument, and an exposure of only forty minutes, he has been able to produce a portrait of Orion's great nebula which, as regards structural detail, will bear comparison with any previously obtained. Good photographs of the Orion nebula and other nebulæ have also lately been taken at the Paris Observatory with exposures of an hour or less (see p 374). A comparison of Mr. Wilson's photograph of the Orion nebula with one recently taken by Dr. Roberts with the same exposure shows that they both contain about the same amount of detail and extent of nebulosity, so the decrease of the time of exposure is

FIG 2.—Great Nebula in Orion. (From a photograph obtained by Dr. Roberts, with an exposure of 7½ hours.)

probably to be accounted for by the use of more sensitive plates than were formerly available. The central part of the Orion nebula, as photographed in forty minutes, is here reproduced by the side of a well-known drawing of the nebula lithographed by Mr. L. Trouvelot in 1864, from drawings made by Prof. G. P. Bond, of the Harvard College Observatory (Fig. 3). We have thus what is undoubtedly the best drawing of the nebula compared with a good photograph on the same scale (Fig. 4), and though much of the fine detail in the latter picture has been lost in reproduction, the difference between the work of the hand and that of the photographic plate is very striking.

Prof. Bond had to use every available hour for about five years in order to determine accurately the structure and distribution of the parts of the nebula. Such devoted perseverance cannot but command admiration, yet, except for the satisfaction which the celestial draughtsman derives from his work, a like expenditure of time and energy would now be almost useless. It is not, however, for the celestial photographer to depreciate the labours of the plodding observer. As Dr. Roberts himself has said, "we ought, with all gratitude, to admire the patient, long-suffering endurance of those martyrs to science, who, during the freezing nights of many successive winters plotted, with pencil in benumbed fingers, the crude outlines which have been handed down to us as correct drawings of this wonderful nebula, which we can now depict during four hours of clear sky with far greater accuracy than is possible by the best hand-work in a life-time" (*Monthly Notices, R.A.S.*, vol. xlix. p. 297, 1888–89).

THE SPIRAL NEBULA IN CANES VENATICI.

The years 1888–89 will be marked with a white stone in the annals of celestial photography, for it was then that so many remarkable proofs of its great capabilities were presented to the astronomical world. A photograph of the wonderful spiral nebula in the constellation Canes Venatici was obtained

FIG. 3.—Bond's drawing of the Great Nebula in Orion (1859–63).

by Herr von Gothard in 1888 (*Astronomische Nachrichten*, No. 2854, 1888), and by Dr. Roberts in April, 1889 (*Monthly Notices, R.A.S.*, vol. xlix. p. 389, 1888–89). Dr. Common appears to have taken a good photograph of the nebula in 1883, but he did not publish any description of it at the time (*Observatory*, vol. xi. p. 393, 1888). An accurate picture of the object was certainly much needed. The nebula had been drawn by Herschel, Rosse, Lassell, and numerous other astronomers, and its convolutions had been more or less symmetrically traced. But so long as only drawings, differing widely from one another, existed of the spiral nebula in Canes Venatici, little was learned about the physical nature of the object. The photographs

FIG. 4.—Photograph of the Great Nebula in Orion, obtained with an exposure of forty minutes.

showed that the whorls of nebulosity were knotted with bright spots—stars in the course of formation—and these followed so closely the trend of the streams of nebulous matter, that their connection with it was placed beyond the possibility of doubt. The picture is a striking view of a stage of progress in the evolution of stellar systems; it exhibits in a most unmistakable manner a "fluid haze of light" eddying into worlds, and enables us almost to see cosmic processes at work. In the accompanying illustration the nebula, as observed with Lord Rosse's six-foot telescope and drawn by hand, is represented (Fig. 5) side by side, and on the same scale, as a photograph of the object obtained by Mr. Wilson with an exposure of forty

minutes (Fig. 6) Considered as pictures, the drawing is perhaps more attractive than the photograph, but this is because the photograph has been enlarged to such an extent that the grain of the film is shown. The comparison should be made between the original negative and the drawing, in order to be able to relative position in the two pictures, when considered with reference to the great nebula. The difference may indicate a change in the direction of the axis between 1847, when the drawing was made, and now, but it would be unwise to conclude that this difference is real, seeing that the distinct statement is

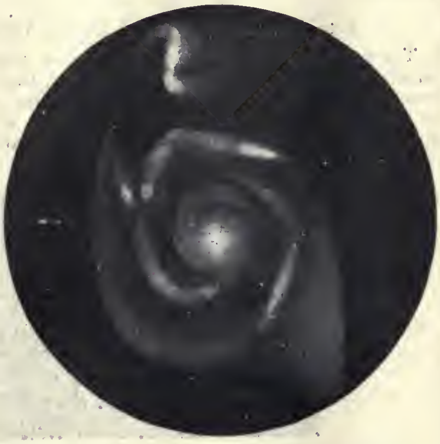


FIG. 5.—From a drawing.

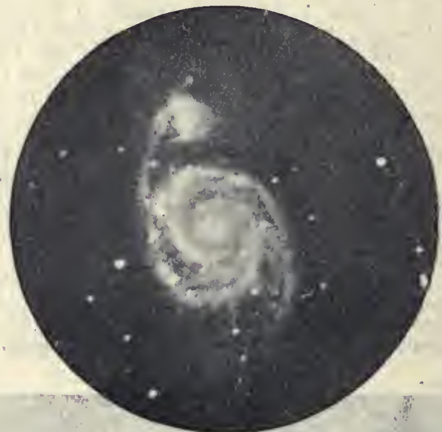


FIG. 6.—From an enlarged photograph by Mr. W. E. Wilson.

The Spiral Nebula in Canes Venatici.

appreciate fully the assistance given by photography to the delineation of the structure of the nebula.

THE ANDROMEDA NEBULA.

Until Dr. Roberts took the photograph of the nebula of Andromeda in 1888 (*Monthly Notices R.A.S.*, vol. xlix. p. 65, 1888-89), astronomers did not understand that this object was a remarkable example of the ring-stage in celestial evolution.

FIG. 7.—The Andromeda Nebula. (From a drawing by Bond and Trouvelot.)

FIG. 8.—The Andromeda Nebula. (From a photograph obtained by Dr. Roberts, with an exposure of ninety minutes.)

Bond's drawing (Fig. 7) was acknowledged to be the finest representation of the nebula, but how much it is inferior to the photograph (Fig. 8) is shown in the accompanying comparison of the two. It will be seen that the major axis of the small nebula near the top on the right has a different made that "the lithograph represents somewhat inaccurately the relative positions of the chief nebulous centres of condensation" (*Annals of Harvard College Observatory*, 1876). But though this possible change is important in itself, it is not so instructive as the rings of nebulosity seen surrounding the bright central portion of the great nebula on the photograph. The dark lanes drawn by Bond are seen upon the photograph to be divisions between the zones of nebulous matter; and what visually appears to be accidental and enigmatical vacuities, are shown photographically to be the consequences of cosmogonical action. The hypothesis of the formation of worlds from nebulæ was thus confirmed, if not demonstrated, by the discovery of this new link to connect celestial species.

The Portrait Lens in Nebular Photography.

It was at one time supposed that large telescopes were necessary to obtain valuable pictures of celestial objects; but as the work went on, it was found that ungainly instruments were not at all essential, and that excellent results were given by instruments of very moderate dimensions. For photographing faint stars, where the images on the photographic plates are practically points, the aperture of the object-glass or mirror is almost the only factor to be taken into account in estimating efficiency; but for nebulæ, comets and similar celestial objects, the images of which cover sensible areas on the plates, the ratio of focal length to aperture is all-important, and the actual aperture is a secondary consideration.

Experience has shown that a lens constructed in the same way as a portrait lens for use in an ordinary camera, is really the best instrument for several branches of celestial photography. The lens must of course be mounted, so that it can be made to follow the motions of the celestial sphere, but in other respects the camera need not differ essentially from that used in the ordinary portrait studio. The advantage of the portrait lens over the photographic telescope is that the field of view is much greater—it is therefore able to take a broader view of things.

The telescopes used for the international star catalogue and chart may be taken as the standard instruments for *star* work. The aperture of the object glass is 13 inches, and the focal length, roughly, 130 inches (ratio 1 to 10), the effective field being a little over 2 degrees square (4 square degrees on the celestial sphere). A portrait lens of 6 inches aperture and 30 inches focus (the favourite size with those who use portrait lenses for celestial photography) has a ratio of aperture to focal length of 1 to 5, and an effective field of 15 degrees square (225 square degrees). In photographing a nebula, this portrait lens only requires about one-half the exposure necessary when the standard telescope is used, while the area covered is nearly forty times as great. It follows, therefore, that for an extended nebula covering over 100 square degrees on the celestial sphere—and such nebulæ exist, and have been photographed—the portrait lens can give in two hours a complete picture comparable, in area of sky covered, with a picture that would require twenty-five exposures of four hours each with the standard star telescope; and that, whereas the picture with the portrait lens would all be on one plate and taken with one exposure, that with the standard telescope would be a mosaic built up from at at least twenty-five plates taken at different times, and consequently under very various atmospheric and astronomical conditions.

During the past eight years or so, a large number of photographs of nebulæ and nebulosity have been obtained by means of portrait lenses; and year by year the work done, both in this and other branches of astronomical photography, has been admirably summarised by Mr. Albert Taylor in the *Photography Annual*. Every one interested in the progress of celestial portraiture should refer to these annual records of results, as we have had frequently to do in preparing the subjoined account of the use of the portrait lens in astronomical photography.

The great advantage of the portrait lens or doublet over the telescope was admirably brought out by Prof. W H. Pickering, who, using a small camera at Wilson's Peak, California, in 1889, obtained a photograph including on one plate the whole constellation of Orion. The great nebula in Orion was clearly shown, but the chief value of the photograph lies in the large number of detached nebulous patches shown, which appear to be part of an enormous zone of nebulosity encircling the great nebula, and practically covering the entire constellation. The existence of this great mass of nebulous matter, and its obvious connection with the well-known nebula in the sword-handle of Orion, would probably never even have been discovered with long-focus instruments with small photographic fields; yet with the portrait lens it is a comparatively easy object.

In 1890, Mr. H. C. Russell, F R.S., obtained a large number of striking photographs of nebulæ and the Milky Way with a 6-inch Dallmeyer portrait lens attached to the mounting of his telescope. The pictures thus obtained show many details of structure which are quite invisible in the telescope. Exposures of between four and five hours brought to light many peculiarities of arrangement of stars in Nebecula Major and Minor—the Magellanic clouds—and showed that the whole of the former apparently detached portion of the Milky Way had the structure of a complex spiral nebula with two nuclei two degrees apart. The Nebecula Minor as portrayed by Mr. Russell's camera bears a resemblance to the well-known Dumb-bell nebula.

Following closely on Prof. W. H. Pickering's work in 1889, the greatest advances in the photography of nebulæ in 1891 were due to Prof. Barnard at the Lick Observatory, Dr. Max Wolf at Heidelberg, Mr. Russell at Sydney, and Dr. Archenhold at Helensec, each of these observers using ordinary portrait lenses.

Dr. Max Wolf, with a 2½-inch aplanatic lens of 7⅝ inches focus, photographed in one hour all the nebulæ in the Pleiades obtained by the Brothers Henry at Paris with four hours' exposure with the 13-inch charting telescope; and afterwards using a 4-inch Vöigtlander Euryscopic lens and a 5-inch Kranz Euroscopic lens, Wolf obtained more extension of the great nebula in Orion in 4 hours than Dr. Roberts had obtained with 4½ hours' exposure with his 20-inch mirror. These same plates of Wolf amply confirmed Prof. W. H. Pickering's results, and revealed an enormous amount of new detail in the nebula around ζ Orionis.

Turning his attention to the constellation Cygnus on June 1, 1891, Dr. Wolf, by 3 hours' exposure with the 5-inch Kranz lens, discovered an enormous nebula full of the most complex structure, and connecting a number of bright stars with many fainter ones in the Milky Way (*Astr. Nach.*, 3048). Starting apparently from a central point, the nebula spreads out branches which curve and meet "fold on fold of nebulous matter surging over the sky" and "becoming notably compact and luminous in the immediate neighbourhood of γ Cygni." Some of these branches are 8° long, so that at least four plates would be required for one of them with a photographic telescope of standard size; but the portrait lens secures all on one plate, and their true relations to each other and to the involved stars become at once apparent.

The great feature of this photograph, and of many subsequent pictures, is the obvious connection between bright stars and fainter ones. It was formerly believed that the brightness of a star was to some extent a measure of its distance from us, but the photographs with portrait lenses effectively disposed of this idea. Stars of nearly first magnitude were found to be joined to stars of the eighteenth magnitude by wisps of nebula, and to obviously form part of the same system in the heavens. These stars, the brightest of which are about 4,000,000 times more luminous than the faintest, must be at practically the same distance from us, and their differences in brightness must be due to differences of size or physical condition, or both, and not to any differences in distance.

Another interesting result from the photographs was the proof of the connection of nebulæ with stars of the Wolf-Rayet type of spectrum—stars with bright lines in their spectra—which Sir Norman Lockyer classifies as stars only just condensed from nebulæ, and next in order of evolution. Dr. Roberts, with 3¼ hours' exposure with the 20-inch mirror, could detect no nebulosity round these stars in Cygnus, but the portrait lenses with exposures extending up to 13½ hours, indicated that all these stars are nebulous.

This work of Wolf was supplemented by some splendid results obtained by Mr. Russell at Sydney Observatory about the same time. The lens used, a 6-inch Dallmeyer of 30 inches focus, gave, with three hours, as much extension of the great nebula round the star η Argus as the 13-inch charting telescope showed with twice that exposure, while the relations of the nebula to the surrounding stars were much better shown. Two long exposures with the same lens on those curious detached portions of the Milky Way in the southern heavens, known as the Nebeculæ Major and Minor, revealed a great amount of previously unknown nebulous matter, much of which would be very difficult to obtain with larger instruments.

Dr. Archenhold, at Helensec, recognising the true principles of photography of celestial objects of large size, had two lenses constructed by Busch, the ratio of aperture to focal length being 1 to 4·5 and 1 to 2·5 respectively. With these lenses he photographed a very striking and extensive nebula near ξ Persei on October 27, 1891, with 32½ minutes' exposure. This new nebula resembles in many respects the great nebula in Andromeda, but probably covers a much greater area of the sky. The great effectiveness of this special lens is shown by eye observations with a 12-inch telescope; for even with the photograph to indicate where to look for details, scarcely any trace of the nebula can be made out (*Astr. Na h.*, 3082). Dr. Scheiner, at Potsdam (*Astr. Nach.*, 3157), has photographed this great nebula with a 4-inch portrait lens, giving exposures up to six

hours. The spiral form is clearly shown, while the extent of the nebula is greatly increased.

Prof. E. E. Barnard, with the 6-inch Willard lens of 30 inches focus at the Lick Observatory, has enormously extended our knowledge of these great diffuse nebulosities. It is quite impossible in the limits of this article to deal with these in detail, but the extraordinary form of the nebula round 15 Monocerotis, the enormous diffuse nebulosities in the constellation Cepheus and round the Pleiades, the tremendous extensions of the Orion nebulæ shown in his numerous articles in *Astronomy and Astrophysics* and the *Astrophysical Journal* since 1893, are all magnificent examples of the use of the portrait lens in photographing nebulæ; and one can have no hesitation in saying that without the portrait lens we should still be in ignorance of many of these wonderful objects. But Barnard has gone beyond the portrait lens, and has used the lens of a cheap oil lantern, the effective aperture of which is about 1½ inches, the focal length being 3½ inches, ratio 1 to 2·3. This gives a field of 30 degrees practically flat, the scale of the photographs being 10·3 degrees to 1 inch on the plate. Twenty photographs in October 1894 (*Astronomy and Astrophysics*, vol. xiii. p. 811) fully brought out the value of this instrument. One hour's exposure gave all the Andromeda nebula; thirty minutes gave all the diffuse nebulosity round the Pleiades photographed by Archenhold in four hours, and by Barnard with the Willard lens in three hours. The most valuable of all results, however, were those with Orion, obtained on October 3 and 28, 1894, with exposures of 2h. and 1h. 15m. The extensive spiral detected by Pickering in 1889 is fully shown in correct proportion, and "no description can give any idea of the form and magnitude of this nebula." Extending over 17 degrees in length and nearly the same in breadth it includes almost all the stars of the constellation, and forms in fact a robe for the body of the giant. The well-known "great nebula of Orion" is but a pigmy compared with the greater nebula revealed by Prof. Barnard's plates, and it is not too much to believe that longer exposure will probably fill the whole constellation with nebulosity, and show that the great nebula is simply the inner termination and the brightest part of the enormous spiral.

An English amateur, Dr. E. M. Sheldon (*Journal of the British Astronomical Association*, vol. v. p. 397), using a lantern lens similar to that used by Prof. Barnard, photographed this enormous spiral in Orion with 1¼ hours' exposure, in February 1895. Four hours on the constellation Cygnus with this lens gave all the nebulæ on Wolf's photograph taken with 13 hours' exposure.

The nebulosities in the Pleiades have attracted great attention since they were first photographed by the Brothers Henry at Paris in 1885. These nebulæ have always been remarkable from their intimate relations with individual stars in the cluster —"Maia is a diamond clasp on a curving plume, Electra extends a tentacle towards Alcyone, while Merope has a sweeping gauze trail and probably a nebulous satellite." In striking contrast to this we usually have in other regions of the sky stars and nebulæ intimately mixed, although frequently on recent photographs wisps of nebulæ are found joining stars, so that the structures appear to resemble festoons of pearls on a gauzy string. The most recent photographs of the Pleiades by Barnard at the Lick Observatory, taken 10h. 15m. exposure with the Willard (6-inch) lens; by Mr. H. C. Wilson, with a similar lens and 11 hours' exposure; and by Dr. Max Wolf, have revealed an enormous extension of the Pleiades nebulosity. The whole area is now 158 square degrees, and there are indications that even this is not the real limit, and that more prolonged exposures will give still greater extension, probably joining up the whole of the nebulosity into an enormous spiral similar to that covering the constellation Orion.

Other photographs exhibiting the same class of structure have been obtained of the region round Antares with 7½ hours' exposure by Prof. Barnard at the Lick Observatory. At first sight this new nebulous mass would easily be mistaken for the Pleiades Nebula, and it is a remarkable and very significant fact that both these masses and all other great nebulosities in the Milky Way either occupy vacancies amongst the stars, or are on the edges of such vacancies; and that in their immediate neighbourhood the stars exhibit long vacant lanes and other remarkable features, indicating that the nebula, stars, and vacant lanes are but different features of some vast and at present imperfectly comprehended system of celestial grouping.

The first results obtained by Prof. Bailey, at Arequipa, with the Bruce photographic telescope of the Harvard College Observatory have lately been recorded. This portrait lens, the largest in the world at present, has an aperture of 24 inches and a focal length of 135 inches, so that while the scale of the photographs is equal to that of the international star charts (1 minute of arc to 1 millimetre), the light-gathering power of the telescope is three times as great, and exposures with this instrument need be only about one-third of those required with the standard international telescopes to achieve the same results. But the Bruce telescope has a further advantage over the standard instruments. Its effective field is 25 square degrees (14-inch by 7-inch plates are used), whereas the effective field of the international instruments is only 4 square degrees in area. The daring experiment of Prof. Pickering in devising, and Mr. Alvan Clark in constructing, this enormous portrait lens has been completely successful (although several eminent astronomers on this side of the Atlantic doubted whether such an instrument could be constructed), and as a result we have an instrument which can do all the international work on less than 4000 plates and with very much reduced exposure. Prof. Pickering does not at present intend to duplicate the work of constructing the photographic chart of the stars, but will confine the instrument to nebulæ and special regions of the sky, and, with the aid of a 24-inch object prism, to spectrum photography. The published preliminary results are of very great value.

This article ought not to be concluded without mention of the fact that more than one astronomical photographer is of the opinion that some of the nebulosity shown upon pictures obtained with small portrait lenses is not real, but due to diffused starlight. A warm controversy has taken place with reference to this point, but this is not the place to present the views of the two parties. It has been shown in this article that large instruments, such as those used for the International Chart, with long focal length but restricted fields, can give us pictures full of delicate details of bright nebulæ, and these photographs are of extreme value; but we must look to the portrait lens for the larger details and for the fainter nebulosities which are absolutely beyond the reach of any photographic object-glass or mirror. There can be no rivalry between the two classes of instruments; each is perfect in its way, each will mislead if solely relied upon. Photographs of the same nebulæ, both with long focus object-glasses or mirrors and with portrait lenses, are necessary, and must be used to supplement each other, if we are to get correct ideas of the phenomena of stellar distribution and the connections between nebulæ and stars. The "best instrument to use" is not a matter of personal experience nor of individual opinion: the optical and photographic laws bearing on the subject are well known, and the practical limits of atmospheric definition and instrumental construction are within sight. The ideal instrument for photographing nebulæ will probably combine large aperture, short focal length, and the large flat field of the portrait lens; will be, in fact, a glorified portrait lens: there are optical reasons why neither the object-glass nor the mirror can be wholly satisfactory. While waiting for this instrument, every possessor of an ordinary rectilinear lens with an ordinary camera can, by strapping his camera on to an equatorially mounted telescope and using infinite patience, materially advance our knowledge of nebulæ by means of photography.

R. A. Gregory.

PHOTO-MICROGRAPHY WITH HIGH POWERS.

PHOTO-MICROGRAPHY has for some years past advanced but slowly, although its present status as a means of delineating minute structure is undoubtedly much higher than it has ever been. In optical appliances the improvements have been many, the most notable being the introduction of apochromatic objectives. Their greater aperture and freedom from effects of the secondary spectrum have combined to render it possible to obtain good results with much greater ease than formerly. Some of the photomicrographs obtained, however, in the early days of microscopy are even now hardly excelled, although they were produced at the cost of enormous labour, and required extraordinary skill on the part of the operator, with the apparatus then available. The production of satisfactory photographs, when the magnification exceeds one thousand diameters, has always been a matter of some difficulty. One of the greatest of these has been the want of a source of illumina-

tion which should be of sufficient intensity without a considerable increase in the size of the illuminating surface. Various attempts have been made to adapt the oxy-hydrogen light for the purpose; but there always remains the objection, that however small the incandescent portion of the lime may be, it does

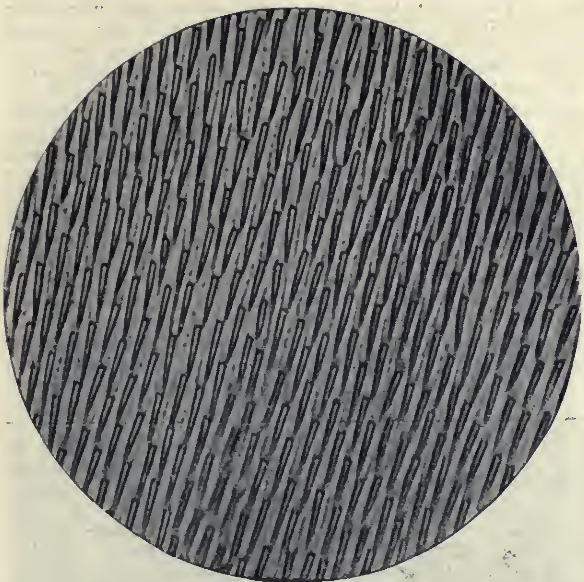


FIG. 1.—Surface markings on Podura scale. Photographed with Swift's 1/12-inch apochromatic, projection ocular 2, and central cone. Magnification, 2500 diameters.

not emit light of equal intensity over the whole of its surface. This can at once be seen if an image of the lime be projected on to a screen. The result is uneven illumination, a defect so often seen in high-power photographs, when the image of the radiant

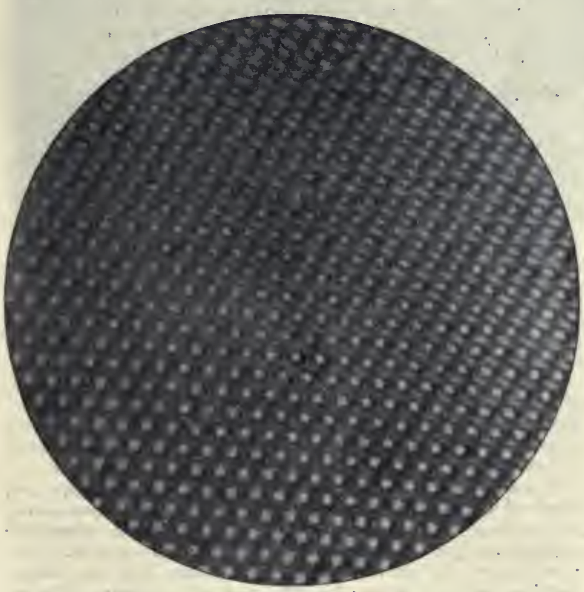


FIG. 2.—*Pleurosigma angulatum*. Photographed with Winkel's 1/20-inch homogeneous immersion, projection ocular 4. Central cone and malachite-green screen. Magnification, 5000 diameters.

is projected by the achromatic condenser across the object, or what is known as "critical illumination."

The electric arc is the light which approaches most nearly to an ideal illuminant. The source of light is extremely small, but the intensity is great, and the incandescent surface is, if working under proper conditions, homogeneous. It has until recently been impossible to so control the arc that these conditions could be obtained with certainty. In all forms of lamp, whether hand-fed or automatic, the difficulty has been to maintain a constant position and condition of the crater on the positive carbon. This can be done by having a simple form of hand-feed apparatus with a pin-hole camera attached, through which an image of the carbon points is projected on to a ground-glass screen. Reference lines are provided on this screen, so that the length of arc and position of the positive crater can be continuously observed. The arrangement was exhibited at the two conversazioni of the Royal Society last year, and has been fully described before the Royal Microscopical Society. With such a form of arc-lamp absolute centiation of the light can be secured and maintained without reference to the microscope, after the necessary position of the image of the arc on the screen of the pin-hole camera has been once obtained. The accompanying illustrations have been reproduced from photographs taken with the arc-light so arranged. Fig. 1 shows the surface markings on a Podura scale, magnified 2500 diameters. Fig. 2 is a frustule of *Pleurosigma angulatum*, magnified 5000 diameters. In neither photograph is there the slightest sign of de-centration, and in both cases centration was maintained entirely without reference to the microscopic image.

J. EDWIN BARNARD.
THOMAS A. B. CARVER.

A METHOD OF MEASURING WIND PRESSURE.[1]

THERE are few physical problems of greater immediate and obvious practical importance, than that involved in the measurement of air pressures under complex conditions of motion, and there are few problems which present greater difficulty, or—what is worse—uncertainty. It may be comparatively easy to obtain under any particular set of circumstances evidences of barometric variation by means of some indicating instrument, apparently suitable for the particular purpose, but it is a very different matter to decide how far the quantitative result is unaffected by actions set up by the instrument itself. Thus the record of the pressure plate gives information which is of little, if any, value in relation to the distribution of pressure over a large building; while the barometer itself is capable of giving misleading indications, whether it is too effectually protected from external influences, or too much exposed.

For measuring the wind pressure at any point of a structure of considerable size, a receiver or collector is required, with a convenient gauge connected by a tube. It is essential that the collector should not itself give rise to compressions or rarefactions affecting the gauge. To the invention of such an instrument Prof. F. E. Nipher has devoted much attention, and his final apparatus seems to fulfil its purpose admirably. Two equal thin metal discs, 2·5 inches in diameter, having bevelled rims, are screwed together, so as to leave a small space between, into which a connecting tube is passed through the centre of one of the discs. The end of the tube is flush with the inner surface, and the interspace is filled up with a certain number of layers of fine wire screen, which project at least half an inch beyond the edges of the metal discs. When this simple device is placed in a stream of air, it is found that the effects of rarefaction and compression, set up at different parts of the porous screen, completely neutralise each other, so that the pressure at the mouth of the tube is the same as the true intrinsic pressure of the external air. This property of the collector was severely tested by thrusting it out of a carriage window in a train which was travelling at the rate of sixty miles an hour: no effect on the gauge could be noticed, although the instrument was sufficiently sensitive to show instantly the effect of placing the hand at a tangent to the edge. The gauge which Prof. Nipher employed was a water manometer consisting of a cylindrical vessel partly filled with water, with a straight glass tube leading out from the bottom and inclined at 5 in 100 to the horizontal. The open end of this tube was in communication with a collector of the form suggested by Abbe[2] so as to secure a standard pressure of comparison.

1 "A Method of Measuring the Pressure at any Point of a Structure, due to Wind blowing against that Structure." By Francis E. Nipher. (*Transactions* of the Academy of Science of St. Louis, vol. viii. No. 1.)

2 Report of the Chief Signal Officer, 1887, 2, 144.

Being now satisfied with the trustworthy nature of his apparatus, Prof. Nipher determined to apply it to the determination of the distribution of pressure over a large pressure board. For this purpose the board, which was a wooden one, 4 feet long by 3 feet wide, was mounted on the roof of a railway carriage. It was bolted to a vertical iron pipe, and the couple required to keep it perpendicular to the direction of the wind was measured by a spring balance. On opposite sides of the board, and at the centre of one of the 108 4-inch squares into which the board was divided, two disc collectors were fixed and connected by rubber tubes with their respective gauges. The latter, together with a third, which was used as a level, were mounted on a board which was rigidly attached to a heavy pendulum within the carriage. The speed of the train varied generally between twenty and fifty miles an hour, and was checked by direct observations.

The total action on the board is the result of an increase of pressure in front and a decrease behind. Both the increase and the decrease are shown by this series of experiments to be proportional to the force necessary to hold the board to the wind as indicated by the spring balance. Further, the force measured in this way differs from that deduced from the data given by the collectors by no more than 1 per cent., and although this may be in a measure accidental, it affords a confirmation of the accuracy of Prof. Nipher's method. On both sides of the board the difference from the ordinary pressure becomes less as the periphery is approached, although there is some evidence of a minimum excess at the centre of the front face. Prof. Nipher gives a few notes on the application of the device to the study of pressure variation around a building. It is to be hoped that such developments as this will be realised. At present it is too early to estimate the full importance of these researches as a contribution to the study of anemometry; but the idea is full of promise, and the simplicity of the apparatus is certainly a great point in its favour.

AN ENCHANTED MESA.[1]

THE pueblo of Acoma, in Western Central New Mexico, is the oldest settlement within the limits of the United States. Many of the walls that still stand on that beetling peñol were seen by Coronado during his marvellous journey in 1540, and even then they were centuries old.

The valley of Acoma has been described as "the Garden of the Gods multiplied by ten, and with ten equal but other wonders thrown in; plus a human interest, an archæological value, an atmosphere of romance and mystery"; and the comparison has not been overdrawn. Stretching away for miles lies a beautiful level plain clothed in grama and bound on every side by mesas of variegated sandstone rising precipitously from 300 to 400 feet, and relieved by minarets and pinnacles and domes and many other features of nature's architecture.

None of these great rock-tables is so precipitous, so awe-inspiring, and seemingly so out of place as the majestic isolated Katzímo or Enchanted Mesa, which rises 430 feet from the middle of the plain as if too proud to keep company with its fellows; and this was one of the many wonderful homesites of the Acomas during their wanderings from the mystic Shípäpu in the far north to their present lofty dwelling-place.

Native tradition, as distinguished from myth, when uninfluenced by Caucasian contact, may usually be relied on even to the extent of disproving or verifying that which purports to be historical testimony. The Acoma Indians have handed down from shaman to novitiate, from father to son, in true prescriptorial fashion for many generations, the story that Katzímo was once the home of their ancestors, but during a great convulsion of nature, at a time when most of the inhabitants were at work in their fields below, an immense rocky mass became freed from the friable wall of the cliff, destroying the only trail to the summit and leaving a few old women to perish on the inaccessible height. What more, then, could be necessary to enwrap the place for ever after in the mystery of enchantment?

This tradition was recorded in its native purity some twelve years ago by Mr. Charles F. Lummis, and the same story was repeated by Acoma lips to the present writer while conducting a reconnaissance of the pueblos in the autumn of 1895. During this visit, desiring to test the verity of the tradition, a trip was made to the base of Katzímo, where a careful examination of the talus (especially where it is piled high about the foot of the great south-western cleft (Fig. 1) up which the ancient pathway was reputed to have wound its course) was rewarded by the discovery of numerous fragments of pottery of very ancient type, some of which were decorated in a vitreous glaze, an art now lost to Pueblo potters. The talus at this point rises to a height of 224 feet above the plain, and therefore slightly more than half-way up the mesa side. It is composed largely of earth, which could have been deposited there in no other way whatsoever than by washing from the summit during periods of storm through many centuries. An examination of the trail to a point within 60 feet of the top exhibited traces of what were evidently the hand and foot holes that had once aided in the ascent of the ancient trail (Fig. 2) as at Acoma to-day. Even then the indications of the former occupancy of the Enchanted Mesa were regarded as sufficient, and that another one of many native traditions had been verified by archæologic proof.

FIG 1.—The Enchanted Mesa—the Great South-western Cleft and Talus Heap.

More recently the author visited Katzímo a second time, on this occasion with Major George H. Pradt, Mr. A. C. Vroman, and Mr. H. C. Hayt, in order to determine what additional data of an archæological nature might be gathered by an examination of the summit.

The ascent of the talus, in which the potsherds had been observed in such considerable quantities two years previously, was made in a few minutes, the ladders, ropes, and photographic and surveying instruments being carried with some effort, since climbing, heavily laden, at an altitude of 6000 feet, in a broiling sun, is no trifling labour; but the real work began when the beginning of the rocky slope of the cleft was reached. One member of the party, taking the lead, dragged the end of a rope to a convenient landing place, where a dwarf piñon finds sufficient nourishment from the storm-water and sand from above to eke out a precarious existence. Fastening the rope to the tree, the outfit was hauled up, and the other members of the party found a ready means of ascent. The next landing was several feet above, at the base of a rather steep pitch of about twelve feet. This wall, although somewhat difficult to scale,

[1] Abridged from a paper by Mr. F. W. Hodge, of the United States Bureau of American Ethnology, in the *National Geographic Magazine*.

may be climbed with greater or less safety by the aid of several small holes in its face. These holes were doubtless made artificially, but as the narrow pathway at this point is now a drainage course during periods of storm, the soft sandstone has become so much eroded that they have apparently lost their former shape.

The summit of Encantada was reached after some difficulty. It has been swept and carved and swept again by the winds and rains of centuries since the ancestors of the simple Acomas climbed the ladder-trail of which we found the traces. The pinnacled floor has not always appeared as it is to-day, for it was once thickly mantled by the sherd-strewn soil that now forms a goodly part of the great talus heaps below.

There is little wonder, then, that the party despaired of finding even a single relic when they had reached the top of the trail and looked about at the destruction wrought; and yet they had been on the summit only a few minutes when a sherd of pottery of very ancient type, much crackled by weathering, was found. This fragment is of plain grey ware, quite coarse in texture, with a dégraissant of white sand.

FIG. 2.—The Great Sandstone Cleft of the Mesa. Through this cleft the traditional trail passed, and distinct traces of it were found on each side of the vertical fissure to the right of the upper ladder.

During the twenty hours spent on the summit, every opportunity was taken of making a critical study of the general features of the top of Katzimo throughout the 2500 feet of its length, special consideration being devoted to the topography of the site, the erosion, the earthy deposits, the drainage, and the great cedars that stand gaunt and bare or lie prone and decaying because their means of subsistence have been so long washed away, and the party was forced to the conclusion that had house-walls, whether of stone or adobe, ever existed on the summit at a reasonably remote period, there was no possibility that any trace of them could have remained to this day. Nevertheless, the abundance of ancient relics in the talus, the distinct remains of the ladder-trail, the specimens found on the summit coupled with the destruction wrought by nature, the tradition itself—all testify to the former habitation of the site.

To the Acomas Katzimo is still enchanted, and as a subject in the study of mysticism the man of science must yet regard it. The law of a millennium is not undone by a few hours of iconoclasm.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—On March 15, Convocation will consider some alterations in the statute relating to the Aldrichian Demonstratorship in Comparative Anatomy, rendered vacant by the resignation of Dr. Blaxland Benham, who has been appointed Professor of Biology at Otago, New Zealand. Mr. Gilbert Bourne, of New College, has, in the meantime, been nominated as Lecturer in Comparative Anatomy, and his name will be submitted to Convocation on the same day.

Dr. Benham will be entertained at a farewell dinner by his colleagues on Friday.

The Junior Scientific Club met on Wednesday evening, March 9. Mr. A. W. S. Fisher read a paper on the salmon, and Mr. T. Annandale discussed the habits of British Amphibia. The officers for next term were elected. The Club proposes to hold its biennial conversazione next term, and arrangements are being pushed forward rapidly.

The cast of the skeleton of Iguanodon, which has been purchased by subscription, has now been set up in the court of the University Museum. Some valuable casts of other fossil reptiles have also been recently added to the collections.

CAMBRIDGE.—The honorary degree of Doctor of Science is to be conferred on Dr. Wilhelm Pfeffer, Professor of Botany in the University of Leipzig, and Croonian Lecturer at the Royal Society.

The Agricultural Examinations Syndicate report that ten candidates presented themselves for Part I., and nine for Part II. of the Examination for the diploma of the University. Six candidates were successful in both parts. The numbers show some increase on those of past years.

Regulations for the Gedge Prize in Physiology, taken in a broad sense, have been published. The prize will be given biennially for an original memoir or essay, and will consist of two years' interest on the capital sum of 1000*l*. Candidates must have worked in the University laboratories during six terms, and be of at least five, and at most seven, years' standing from matriculation.

The application for the recognition of St. Edmund's Hostel as a place of residence for students preparing for the secular priesthood of the Church of Rome, led to an animated discussion in the Senate on March 3. The weight of opinion was in favour of granting the application.

THE Senatus Academicus of the University of Edinburgh have resolved to offer the honorary degree of Doctor of Laws to Mr. Horace T. Brown, F.R.S.

PRESIDENT CHARLES DE GARMO, of Swarthmore College, Pa., has been elected to the professorship of the science and art of education at Cornell University, rendered vacant by the resignation of Prof. S. G. Williams; and Prof. Herbert Hibbard, of the University of Minnesota, has been elected assistant professor of mechanical engineering of railways and principa of the graduate school of railway, mechanical engineering.

NEARLY 55 per cent. of the net total of the Estimates for Civil Services, agreed to by the House of Commons on March 3, arises under the class of education, science and art, which shows a net increase of 457,094*l*. over the grants of last Session. To the total of the class—viz. 11,965,796*l*.—the three Public Education Estimates contribute 11,028,776*l*., being a net increase of 425,903*l*. The chief remaining increase is 22,663*l*. under the Science and Art Department Estimate (mainly for additional payments to science schools for attendance and on results). "An important change has been effected in transferring to the Education Departments, England and Scotland, the grants, &c., for drawing in elementary schools, hitherto borne on the Science and Art Department's Vote, and in transferring to the Scotch Education Department the other Science and Art grants in Scotland.

A NOTEWORTHY feature of the little volume of announcements of classes held in the Northampton Institute, Clerkenwell, is a table of special courses adapted to various classes of students. By referring to this table, any young artisan can see what courses he ought to take to educate himself in the scientific principles of his trade. Similar guides to study, now often inserted in the prospectuses of technical institutes, are of great value in inducing students to take up systematic courses of instruction,

and the Northampton Institute has done well to adopt such a means of encouraging earnest work. The Lord Mayor and Sheriffs have consented to pay a State visit to the Institute on March 18, for the purpose of inspecting it and declaring it formally open. The buildings and equipment have up to the present cost over 80,000*l.*, and the expenditure upon the latter is not yet complete. In addition the land—over one and a quarter acres—generously given by the late Marquis of Northampton, is estimated to be worth not less than 25,000*l.* The Institute is a branch of the City Polytechnic, and is situated in one of the busiest parts of the metropolis immediately north of the City boundary.

FROM the sixth annual report of the Technical Instruction Committee of the City of Liverpool, we gather the following items:—The Committee clearly recognises that technical education is inseparably bound up with general secondary and higher education, and must be organised in vital connection therewith.—After some delay, a commencement has been made with the erection of the new Central Technical Schools. The cost of the erection of the building comprising the new schools and the museum extension will be nearly 90,000*l.*—The Committee remark that it would be more satisfactory if greater attention were paid to mensuration and other practical applications of elementary mathematics; since it is a frequent complaint, on the part of teachers of special technical classes, that their students come to them with too little mathematical knowledge and aptitude, and are often unable to grapple with even simple quantitative problems. This difficulty not only applies to Liverpool, but to technical classes in most parts of the country.—The co-operation of the University College with the educational work of the Committee is most satisfactory, and is of great assistance in the construction of an organised scheme of technical instruction.

THE London University Commission Bill was read a second time in the House of Lords on Friday last. In moving the second reading, the Duke of Devonshire pointed out that the measure was founded on the recommendations of the Royal Commission which reported in favour of the two functions of teaching and examining being combined in one University for London. The Bill is substantially the same as that which passed the House of Lords in the last Session of Parliament, but reached the House of Commons too late to be carried through all its stages. To provide against the occurrence of a similar difficulty, the Bill has been introduced earlier in the year than has hitherto been found possible; which gives grounds for the hope that it will take its place on the Statute-book before the close of the present Session. A very large part of the formidable opposition against the Bill has been removed by the introduction of certain modifications. These amendments are in the direction of restricting the power of any future Senate to alter the statutes or regulations made by the Statutory Commission in accordance with the provisions contained in the schedule of the present measure. "I cannot even now assert that opposition no longer exists," said the Duke of Devonshire, "but it is very difficult indeed to understand upon what grounds the measure can be opposed. I have endeavoured to show by what an overwhelming amount of scientific teaching, opinion, and experience it is supported, and I am utterly unable to discover any weight of opinion on the other side which can for a moment enter into competition with the expressions in its favour." Lord Herschell and Lord Reay warmly supported the Bill, which was then read a second time

AT the recent meeting of the Federated Institution of Mining Engineers, Prof. Henry Louis, Durham College of Science, Newcastle, read a paper on "Technical Education in Mining," which should be seen by all Technical Education Committees having mining classes. Prof. Louis made, at the outset, a broad distinction between the training suitable to the working miner or subordinate mine official, and that suitable to mining engineer or general manager. As regards the former he ought to leave his Board school in about the fifth standard, and commence receiving his technical instruction—a very different thing from technical education—underground, whilst continuing his scientific education in evening continuation and science schools. It is greatly to the discredit of the powerful and wealthy miners' unions of this country, that they make no attempt to provide the rising generation with scientific training bearing on their work, especially seeing that such training is the best possible safeguard against accident. For both working miners and engineers, the present legislation, that takes no account of time spent in learning the sciences underlying the art of mining, is most pernicious. Mining students ought to enter some mining college at the age of seventeen, and devote at least three years to learning first the pure and then the applied sciences that they will require in their profession, but none of the pure sciences need to be studied very profoundly. The systematic neglect of the study of dressing of minerals in this country has already had serious commercial results, *e.g.* at Nenthead, and its cultivation is urged. Prof. Louis suggests the introduction of the American system of "Summer Mining Schools" as a method worthy of trial for giving college students an insight into practical work, but points out that college work alone without practical experience is insufficient. On the very open question as to whether college work should precede or follow practical training, Prof. Louis holds the former to be probably the better plan. He concludes with the following recommendations. (1) Every manager of a mine, whether coal or metalliferous, to hold a certificate. (2) Examinations for certificates to be controlled by a central Board, and made uniform in conditions and character for the whole of Great Britain (and if possible for the Colonies also). (3) Residence in a recognised science college to count as part of term of apprenticeship, whilst not less than three years underground should also be insisted on. (4) Every mine surveyor to hold a certificate of proficiency.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 27.—"Mathematical Contributions to the Theory of Evolution. On the Law of Ancestral Heredity." By Karl Pearson, F.R.S., University College, London.

The Darwinian theory has for its main factor the perpetuation of favourable variations by natural selection under the law of heredity. Hence any complete quantitative treatment of evolution must deal (1) with the nature and distribution of variation; (2) with the nature and influence of selection, and this not only upon the selected but upon all correlated characters or organs; and (3) with the law of heredity. Earlier published and other written but unpublished papers of the present writer cover to some extent the ground of (1) and (2). Although the mathematical theory of variation and selection is yet very far from completion, the general lines on which it will proceed seem fairly clear. With the law of heredity, however, the case has hitherto been different. Much has been written on the subject, much has been attributed to inheritance, but the quantitative measurements and facts have formed such a small and slender proportion of the whole, that it has been extremely difficult to base a rounded mathematical theory on what is really known.

The very suggestive theory of heredity developed in Mr. Galton's "Natural Inheritance" has two main features: (*a*) a theory of regression, which states the average proportion of any character which will be inherited under any degree of relationship. This theory is very simple: if the average of the sons of any parent has w of the parent's deviation from the average parent, then the average grandson would have w^2 of the deviation, and so on. Collateral heredity is also determined, and for two brothers was found equal to $2w$. Mr. Galton's value of w was $\frac{1}{3}$.

(*b*) A law of ancestral heredity. According to this law the two parents contribute $\frac{1}{4}$, the four grandparents $\frac{1}{8}$, the eight great grandparents $\frac{1}{16}$, and so on, of the total heritage of the average offspring.

These two parts of the theory, however, are not in entire agreement.

The recent publication of Mr. Galton's remarkable paper on ancestral heredity in Bassett hounds has, however, led the writer to reconsider (*b*). If that law be true, then for every organ and for every grade of kinship the amount of heredity is numerically determinable. The solution of the problem of heredity is thrown back upon the solution of an infinite series of linear equations. Their solution gives results which seem to the writer in good agreement with all we at present know about the influence of heredity in various degrees of kinship. For example, fraternal is no longer *twice* filial regression, but has a value (0·4000) well in accordance with calculations of English stature and Indian cephalic index. In short, if we discard Mr. Galton's relations between the regressions for various grades of kinship, and start

solely from his law of ancestral heredity, the whole theory of heredity becomes simple, luminous, and well in accordance with such quantitative measurements as have so far been made.

It is possible to somewhat generalise the law of ancestral heredity. Modifying Mr. Galton's definition of midparent, a conception is formed of the mid-sth parent, a sort of mean of the ancestry in the sth generation, and the contribution of this mid-sth parent to the offspring is assumed to have a constant ratio to that of the mid-$(s + 1)$th parent, whatever be the value of s. With this simple law the whole of heredity is found to depend upon a single constant γ, termed the *coefficient of heredity*. γ may vary from organ to organ and from race to race. It may itself be subject to selection, if heredity be not looked upon as *à priori* given and antecedent to any evolution by natural selection. In Mr. Galton's statement of the law, $\gamma = 1$. This may really be the case, but it is not necessary to the theory, and it is not required by any facts as yet observed.

Given this simple law of ancestral heredity, there flow from it the following results:—

(1) Heredity between any grade of individual kinship.

(2) The value of the stability that results from any long or short process of selective breeding, and the variability of the breed so established.

(3) The law of cross heredity, *i.e.* the degree of relationship between two *different* organs in kindred.

(4) That panmixia without active reversal of natural selection does not lead to degeneration.

It may be of interest to add that since the law of ancestral heredity allows for the variability of each individual ancestor from the ancestral type, giving that variability its share in the heritage of the offspring, it is inconsistent with Weismann's theory of the germplasma. It does not, of course, answer one way or the other the question as to the inheritance of acquired characters.

Thus Galton's law of ancestral heredity leads to, what has not hitherto existed, a rounded and comprehensive theory of heredity. It describes with surprising closeness all facts so far quantitatively determined, and opens up a wide range of conclusions which await testing by fresh data. Should those data be in agreement with its predictions, then the law of ancestral heredity will in the future play as large a part in the theory of evolution as the law of gravitation has played in planetary theory. It is the quantitative basis on which Darwinism, the evolution of species by natural selection *combined with heredity*, will then be placed; and at one stroke it will clear away a veritable jungle of semi-metaphysical speculations and hypotheses, and this for the simple reason that it is based upon quantitative observations and not on verbal subtleties. It will be difficult, perhaps, to make people realise that there is a science of heredity, simple and consistent, in existence; yet even at the present time it is the number of observers and experimenters, rather than the science, which needs to be strengthened.

"The Magnetic Properties of almost pure Iron." By Ernest Wilson.

In the Siemens Laboratory, King's College, London, a series of experiments were carried out on a ring of iron containing only about ·12 per cent. impurities. The ring was tested as received and after careful annealing. As received, the magnetic hysteresis loss was slightly greater than in an exceptionally good sample of transformer plate examined by Ewing. After annealing the hysteresis loss was still slightly inferior to the Ewing specimen, but an exceptionally large value was obtained for its maximum permeability; μ being 5490 for B = 9000 C.G.S. units per square centimetre. The coercive force for maximum B = 15,720 is 1·13 C.G.S. units. Further experiments were carried out to investigate the apparent magnetic instability of the specimen. The author finds that this effect cannot be accounted for by the self-induction of the ring, nor the time taken for the current to rise to its full value. A method is explained for testing the rapidity with which the current rises to its maximum value. The propagation of magnetism in the ring as affected by induced currents is dealt with, and it is pointed out that these may have an effect on the observations, although it is difficult to account for such times as five and ten seconds, unless the molecule itself be considered. It is deduced from the experiments that the amplitude of induction might not be so great for high frequency and small induction density, which would be of importance in the case of transformer cores if it existed. Reference is made to experiments with alternate currents which show no such diminution; but it is pointed out that experiments with alternate currents would be difficult to carry out, on account of the necessary accurate control of the magnetising force.

"The Kelvin Quadrant Electrometer as a Wattmeter and Voltmeter." By Ernest Wilson.

Two of these instruments were available to the author when carrying out the series of tests described in this paper. He was thus able to use one in connection with a revolving contact-maker to determine the instantaneous rate at which work was being done by alternate currents while testing the other as a direct-reading wattmeter. The author finds that by the contact-maker method he gets good accuracy by taking ten positions of the contact-maker per half-period, and calculating directly from the figures without integrating the curves. When current and potential were in phase an agreement within 1 or 2 per cent. was obtained between the watts calculated this way and the product of the square root of mean square values given by an ammeter and voltmeter. The use of a small mallet for gently tapping the electrometer base is recommended to overcome the effects of viscosity of the acid in the electrometer when this is old, although in the new form of instrument the viscosity gives little or no trouble, since the sensibility is not so great. The wattmeter constant was determined for various frequencies, phase differences, amplitudes, wave forms, and the results show that the Kelvin quadrant electrometer can be used with accuracy as an alternate current wattmetter, but that it is necessary to make sure that within the range of potentials applied Maxwell's formula is verified. Two methods of doing this are explained. The author observed a potential of nearly half a volt, due to the revolving contact-maker alone, when directly placed across the electrometer; but this inductive effect disappeared when a capacity, large compared to that of the instrument, was placed across it. The paper concludes with an interesting note on a manganin strip used for comparatively large currents. The experiments were carried out in the Siemens Laboratory, King's College, London.

February 3.—"The Pharmacology of Aconitine, Diacetylaconitine, Benzaconine and Aconine, considered in relation to their Chemical Constitution." By J. Theodore Cash, M.D., F.R.S., and Wyndham R. Dunstan, M.A., F.R.S.

In this research the pure alkaloids aconitine, benzaconine and aconine derived from *A. Napellus*, and an aconitine derivative, diacetylaconitine were examined with reference to their action upon warm- and cold-blooded animals, a similar series of experiments being made with each alkaloid for purposes of contrast.

It was found if the dose of aconitine, which is invariably lethal per kilo. body weight, be represented by the unit, that (in very general terms) diacetylaconitine would have $\frac{1}{40}$" of the toxicity of aconitine, benzaconine $\frac{1}{300}$, and aconine $\frac{1}{3000}$. There is, therefore, an enormous variation in toxicity amongst these alkaloids.

A few of the chief results obtained are here summarised.

Aconitine in small doses slows the pulse, whilst larger proportions not only accelerate but disturb the sequence of ventricles upon auricles—an independent rhythm being produced at one stage of action. The central vaso-motor apparatus is much more powerfully affected than the peripheral, great respiratory acceleration precedes slowing, which, according to the dose, may pass into failure. Sensory nerves are depressed in function, whilst motor-nerve terminations and skeletal muscle retain their activity, except when largely hyperlethal doses have been used.

Diacetylaconitine has less tendency to cause disturbance of sequence between auricles and ventricles; but, apart from variations in this and other minor points, its action is in the main like that of aconitine.

Benzaconine alters the cardiac rhythm, the pulse becoming much slowed; and at one phase of action the sequence of ventricle fails to every second auricular beat. Entire suspension of contraction may even occur, both auricles and ventricles, followed by spontaneous resumption of systole. Respiration is slowed from the first.

Sensory nerves are but little affected, whilst motor-nerve endings and, to a lesser degree, skeletal muscle show a reduced and curiously intermittent response to stimulation.

Aconine strengthens the cardiac systole, and is opposed to the dislocation of rhythm produced by aconitine, to which it therefore acts in a large measure as an antagonist and antidote. On motor-nerve termination it has a curare-like effect.

All the alkaloids examined reduce body temperature, though in varying degree.

In conclusion it is pointed out that, whilst the toxicity of aconitine mainly depends on the presence of the acetyl group, the introduction of two additional acetyl groups into the aconitine molecule does not materially alter the pharmacological action, but merely reduces the toxicity of the parent alkaloid. The *removal* of the acetyl group abolishes the stimulant action upon the respiratory centre and pulmonary vagus. It also favours reduced activity in motor, rather than in sensory nerve endings.

The benzoyl group—present in benzaconine, absent in aconine—causes a peculiar and distinct modification in the heart's action, associated with a disturbance of sequence never witnessed after aconine. The curare-like effect of aconine, and the intermittent failure of the stimulated benzaconine muscle, are also traceable to the modification in chemical constitution arising from the absence or presence of the benzoyl group.

Attention is drawn to the practical bearing of the fact that benzaconine and aconine, pharmacological antagonists of aconitine, occur with it in the root of *Aconitinum Napellus*, from which the medicinal preparations of the drug are made.

February 10.—"Contributions to the Theory of Alternating Currents." By W. G. Rhodes, M.Sc. (Vict.).

This paper was divided into two parts. Part I. dealt with a method of finding the steady values of alternating currents in any circuits or systems of circuits, without having to perform integrations of differential equations which may be somewhat complicated.

Part II. was devoted to the consideration of the effects of higher harmonics in E.M.F.s and currents on the values of the impedances and reactances of circuits.

Among other results it was shown that periodic E.M.F.s and corresponding currents can in all cases be represented by simple sine curves having the same root mean square values, and suitable phase positions depending on the time constants of the circuits and on the periodicities of the harmonics present.

February 17.—"On Artificial Temporary Colour-Blindness, with an Examination of the Colour-Sensations of 109 Persons." By George J. Burch, M.A.

By exposing the eye to bright sunlight in the focus of a burning-glass behind a red screen, a condition of temporary red-blindness is induced during which scarlet geraniums appear black and roses blue. Green-blindness and also violet-blindness may be produced by similar means.

The author has systematically investigated the appearance of the spectrum during the colour-blindness induced by exposure to intense light from various parts of the spectrum, and finds that the red from A to B, the green near E, the blue half-way between F and G, and the violet at and beyond H, produce well-defined and characteristic results, indicating that each of these colours corresponds to a definite colour-sensation.

In each case all direct sensation of the colour used for fatiguing the eye is lost, but the observer is conscious of a positive after-effect of the same colour, by which the hue of all other colours is modified. The temporary abolition of any one colour-sensation is without effect on the intensity of the remaining colour sensations. Any two, or any three, of the four colour sensations, red, green, blue, and violet, can be simultaneously or successively exhausted. The observed facts are, in the author's opinion, more in accordance with the Young-Helmholtz theory than with that of Hering, but they imply the existence of a fourth colour-sensation, namely blue.

Physical Society, Feb. 26.—Mr. Shelford Bidwell in the chair.—The meeting was held at Eton College. The President informed the Society of the resignation of one of its Hon. Secretaries: Mr. T. H. Blakesley, M.A. In doing so, he referred to the many important services rendered to the Society by Mr. Blakesley, and he expressed the Society's deep and general regret that Mr. Blakesley should now feel unable to continue them. The Council elected Mr. W. Watson to the office of Hon. Secretary.—Prof. T. C. Porter, in whose laboratory the meeting was held, said it gave him very great pleasure to welcome the Physical Society. Eton had been most properly called "the English home of ancient classical learning." For the education of youth, classics had proved themselves of cardinal value. He believed that other Fellows of the Physical Society, with himself, desired that this revered tradition of classics should be maintained at Eton; at the same time, they would agree with him that there was no better supplement to classics than a fair knowledge of the natural sciences. Prof. Porter then gave a lecture, illustrated by lantern photographs, on "Observations on the Peak of Tenerife." He also described his method for measuring the diameter of the earth. The method consists in observing the shadow cast by the Peak upon the sea, and measuring the time that elapses between the moment when the apex of the shadow touches the sea-horizon, and the instant when it is eclipsed by the shadow of night. Prof. Porter called attention to a phenomenon hitherto unnoticed, *i.e.* that the heated air ascending from the Peak casts a shadow, seen as a faint prolongation of that of the Peak; it rises obliquely from its apex. A photograph was exhibited, taken on a quarter-plate, in which is visible the curvature of the horizon as viewed from the altitude of the Peak. An interesting series of unique photographs, illustrating the conformation of the Peak and the phenomena of sunrise and twilight in that latitude, was also shown. In regard to twilight he noticed that the first approach of night, as observed looking eastward, is marked by a dark border of about five degrees width, followed by a sky somewhat lighter. The lecturer discussed also a new theory of geyser action. The theories of Bunsen and others fail to explain why the geyser-throat appears almost completely full at the end of an eruption. This immediate refilling is the more remarkable when it is remembered that some geysers of the Yellowstone region discharge a million and a half gallons at each eruption, and that the eruptions may occur at five-minute intervals. Moreover, the theories generally accepted assume steeper temperature-gradients than those in a region like Yellowstone. Prof. Porter suggests that the phenomena are better explained on the assumption of an arrangement of strata such as exists in artesian-well districts, the throat or shaft of the geyser being in the position of a well communicating with a subterranean stream—the "tube" of the geyser. From the disturbed nature of the region the tube of the geyser follows a waved course; the "shaft" rises from the crest of the terminal wave; the other crests may be steam-traps. Since a basin-like formation is characteristic of all geyser regions, it is fair to assume that the end of the tube remote from the shaft has an outcrop in the hills that form the sides of the basin. By means of this outcrop, water continually flows into the tube. When the tube does not sink deeply enough to attain the temperature necessary for the generation of steam, a quietly-flowing hot-spring is the result. But if, at any point, the tube descends to underground temperatures sufficiently great, steam is formed, and is trapped at the highest point of a bend. Ultimately this steam checks the flow of water, until the accumulated head of cool water from the hills overcomes the resistance, condenses the steam, and re-establishes liquid continuity. Urged by the pressure behind it, the stream is impelled towards the geyser throat; it forces the hot water before it until equilibrium is once again restored in the tube. Prof. Porter afterwards exhibited a method for viewing lantern projections in stereoscopic relief. A slotted disc rotates in front of two lanterns. These project two stereoscopic views in rapid alternation upon a screen, in such a way that the two projections are approximately superposed. In the rim of the disc, other slots are cut, through which the observer looks. The arrangement of slots is such that the right or left eye is only able to see the screen at the moment when its own picture (*i.e.* the picture from the right or left lantern) is on the screen. When the rotation is sufficiently rapid, the views appear as one, without "flicker," in stereoscopic relief.—The President proposed votes of thanks, and the meeting was adjourned until March 11.

Entomological Society, February 16.—Mr. G. H. Verrall, Vice-President, in the chair.—Mr. G. C. Champion exhibited specimens of *Isodermus gayi*, Spin., from the Straits of Magellan, and *I. planus*, Er., from Tasmania, both found by Mr. J. J. Walker. The genus, *Isoderma*, belonging to the Aradidæ, afforded an interesting case of geographical distribution, the only known species occurring in Chili, Australia and Tasmania.—Mr. C. O. Waterhouse referred to the similar distribution of other species of insects, which went to support the theory of a former connection between South America and Australia.—Mr. Champion also showed an example of *Bagous lutosus*, Gyll., from Sweden. This insect had been on the British list since the time of Stephens, but possibly in error, as all the examples he had seen in collections were wrongly so named.—Mr. Jacoby ex-

hibited a pair of the singular weevil, *Apoderus tenuissimus*, Pasc., from the Philippines.—Mr. Burr exhibited species of Orthoptera, of the family Eumastacidæ, resembling dead leaves. This was the only family of Acrydiidæ in which such resemblances were found.—Dr. Chapman exhibited a specimen of *Zygæna exulans* with six wings, the supernumerary pair arising between the normal left forewing, and the corresponding leg on the same side. The uppermost wing appeared normal in every respect, the second was a reduced copy of the basal half of a forewing, and the third a portion of crumpled wing-structure.—Mr. O. E. Janson exhibited a pale variety of the rare *Papilio mikado* taken in South Japan.—Mr. Tutt showed a variety of *Enodia hyperanthus*, taken by Mr. F. H. Day near Carlisle, and banded on the underside like a *Cœnonympha*; also two moths from the same neighbourhood, which, after careful comparison, he regarded as females of *Hydrilla palustris*. This sex was almost, or quite, undiscovered in Great Britain, and the occurrence of the species so far from the fen-district was remarkable.—Mr. H. J. Elwes read a paper, entitled "A Further Revision of the Genus *Erebia*," which was illustrated by the exhibition of examples of every known species. Tracing the geographical distribution, he stated that the principal European centres of the genus were the Pyrenees, and especially the Alps, only a few forms occurring in Scandinavia, while the Ural Mountains and Caucasus were almost destitute of species. The genus became abundant in East Siberia, from which region the few North American forms appeared to have been derived.—Dr. Chapman also read a paper on the species of the genus *Erebia*, a revision based on the male appendages, illustrated with drawings of these organs in about sixty species.—In connection with the above papers Mr. Tutt exhibited and made remarks on long series of *Erebia nerine*, *E. glacialis*, *E. euryale*, *E. ligea*, &c., chiefly from the Alps.

PARIS.

Academy of Sciences, February 28.—M. Wolf in the chair.—Chemical action of the silent discharge: oxides of carbon and nitrogen, by M. Berthelot. A continuation of a previous paper. Mixtures of carbon monoxide and nitrogen, submitted to the prolonged action of the silent discharge, give only the sub-oxide C_4O_3, the nitrogen being unchanged. With excess of hydrogen, a condensation product of the empirical formula $(CH_2O)_n$ is produced. For carbon dioxide, six hours' action with hydrogen in excess caused the almost complete absorption of the oxide. With nitrogen in addition an amido-compound and some ammonium nitrite were formed.—Chemical action of the silent discharge: alcohols and etherial derivatives in presence of nitrogen, by M. Berthelot. The systems studied were mixtures of nitrogen with methyl alcohol, ethyl alcohol, normal propyl, isopropyl and allyl alcohols, phenol, pyrocatechol, resorcinol, hydroquinone, pyrogallol, glycol, and methyl and ethyl ethers.—Fuchsian functions and the equation $\Delta u = e^u$, by M. H. Poincaré.—On a particular case of the motion of liquids, by M. E. Fontaneau.—On the Euler transformation and the determination of singular points of a definite function by Taylor's development, by M. Ernst Lindelöf.—On an extension of Gauss's method of quadrature, by M. Henry Bourget.—On autocollimating telescopes, and an optical verifier of the lines and surfaces of machines, by M. Ch. Dévé. The arrangement described, which is illustrated by three diagrams, permits of the exact verification of the accuracy of plane surfaces, or of the parallelism of two surfaces.—Lines of force and equipotential surfaces in nature, by M. G. M. Stanoiévitch. The paper is illustrated by three plates showing the analogy between the lines of growth in plants and equipotential surfaces. The nodes in the wood play the part and produce the same disturbances in the cellular field as magnetic or electric poles in their respective fields.—On the properties and crystallisation of anhydrous barium sulphide, by M. A. Mourlot. The crystallised sulphide was obtained in two ways: by submitting amorphous barium sulphide, previously prepared by the action of hydrogen sulphide upon barium carbonate at a red heat, to the temperature of the electric furnace, and by heating directly in the electric furnace a mixture of barium sulphate and carbon in the exact proportions necessary to form the sulphide. In this way white crystals belonging to the cubic system were obtained, which behave toward chemical reagents like the amorphous form, except that the action is somewhat slower in the case of the crystals. The behaviour of the sulphide towards fluorine, oxygen, and oxidising agents, phosphorus oxychloride, and carbon was studied.—Action of carbon monoxide upon palladious chloride, by M. F. Finck. By the interaction of these two substances three compounds can be isolated, $COPdCl_2$, $C_2O_2PdCl_2$ and $C_3O_3Pd_2Cl_4$, corresponding to the analogous platinum compounds.—On hydrocinnamide, by M. Marcel Delépine. The crystallised hydrocinnamide has the composition $2C_{27}.H_{24}.N_2.H_2O$, and possesses the properties of the glyoxalidines. It is a base forming stable salts, and the name cinnamine is proposed as more suitable than hydrocinnamide.—On an oxyptomaine, by M. Œschner de Coninck. The pyridic ptomaine described in an earlier paper, and which possesses the composition of a collidine, is easily oxidised by hydrogen peroxide to an oxycollidine,

$$C_8H_{10}(OH).N,$$

from which the original base can be regenerated by distillation with zinc-dust.—On the oxidation of sorbite to sorbose, by M. Gabriel Bertrand. An examination of the experiments of M. Matrot upon the same subject, according to which sorbose is produced whatever ferment be employed in the oxidation. This result is controverted in the present paper, the method of oxidation used by M. Matrot, in which the cultures are exposed to contamination by air organisms, being the cause of the effects observed.—On the preparation of white wines from red grapes, by M. V. Martinand. The fermentation is interrupted by cooling, and the colour removed by aëration of the liquid. After filtration from the solid deposit, the fermentation is completed.—On the influences of intermittent rest and work upon the mean power of a muscle, by MM. André Broca and Charles Richet. When the load on the muscle is below a certain limit, intermittent repose is harmful; for moderate loads, without any effect; and with still greater weights, favourable to the production of work.—Evolution and structure of the conjunctive elements in *Paludina*, by M. Joannes Chatin.—The dissociation of the egg in a large number of distinct individuals, and the cycle of evolution in *Encyrtus fuscicollis*, by M. Paul Marchal.—On optical anomalies and polymorphism, by M. Fréd. Wallerant.—Contribution to the geology of Lower Sénégal, by M. Stanislas Meunier.

AMSTERDAM.

Royal Academy of Sciences, January 29.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Jan de Vries, on some groups of circles. Construction of a system of n lines, forming (n_3) triangles, whose circumscribed circles pass through the same point. Inversion of a quadrilateral and its four circles into a spherical configuration of eight points and eight circles. The analogous spherical configuration 16_5 in connection with Miquel's theorem on the pentagon.—Prof. Martin exhibited a new crystalline form of gold, a perfect tetrahedron, found in Brazil. On the ground of the existence of this crystal the speaker considered hemihedrism of gold possible, though not proved by this single specimen.—Prof. Kluyver presented a paper, entitled "On the binominal development," dealing with the Rev. Simmons's New Theorem in Probability (*Proceedings* of the London Mathematical Society, 1895, p. 290). A method of investigation entirely different from that used by the Rev. Simmons enabled the author to confirm the results arrived at by the latter, concerning the "complete sets" of trials. As for the "broken sets," the same method led to a first approximation of the "advantage," from which it was possible to derive the conditions that must be satisfied, if the probability of net gain is to exceed the probability of net loss.—Prof. Jan de Vries presented, on behalf of Dr. G. de Vries, of Haarlem, a paper entitled "Le tourbillon cyclonal." By this the author means a vortex, which is at the same time both a ring vortex and a columnar vortex, in which, consequently, motion takes place along spirals. After deducing the equations of motion in cylindrical coordinates, a general solution is given, through which a differential equation for the current function is arrived at.—Prof. Moll presented, on behalf of Mr. J. H. Bonnerra, of Leeuwarden, a paper entitled "Sedimentary Erratics of Kloosterholt" (Heiligerlee). The erratics treated of in this paper have been gathered from boulder-clay. While the sedimentary erratics from Groningen bear a great resemblance to certain strata in the Russian Baltic provinces, those of Kloosterholt are more like certain Swedish rocks. As regards their geological age, most of them must be classed with the Silurian and the Chalk formation, while Cambrian Jurassic and Tertiary formations are more sparingly represented.

DIARY OF SOCIETIES.

THURSDAY, MARCH 10.

ROYAL SOCIETY, at 4.30.—(1) On the Rotation of Plane of Polarisation of Electric Waves by a Twisted Structure. (2) On the Production of a "Dark Cross" in the Field of Electro-magnetic Radiation: Prof. J. C. Bose.—An Extension of Maxwell's Electro-magnetic Theory of Light to include Dispersion, Metallic Reflection, and Allied Phenomena: E. Edser.—On the Relative Retardation between the Components of a Stream of Light produced by the Passage of the Stream through a Crystalline Plate, cut in any Direction with respect to the Faces of the Crystal: J. Walker.—On the Relation between the Diurnal Range of Magnetic Declination and horizontal Force, and the Period of Solar Spot Frequency: W. Ellis.

ROYAL INSTITUTION, at 3.—Recent Researches on Magnetism and Diamagnetism: Prof. J. A. Fleming, F.R.S.

SOCIETY OF ARTS (Indian Section), at 4.30.—India and Sir Henry Maine: Charles Lewis Tupper, C.S.I.

MATHEMATICAL SOCIETY, at 8.—The Geodesic Geometry of Surfaces in non-Euclidean Space: A. N. Whitehead.—The Transformation of Linear Partial Differential Operators by Extended Linear Continuous Groups: Prof. Elliott, F.R.S.—Stereographic Illustrations of Catenaries: Prof. Greenhill, F.R.S., and T. I. Dewar.—On Linear Homogeneous Continuous Groups whose operations are Permutable: Prof. W. Burnside, F.R.S.—Supplementary Note on Aurifeuillians: Lieut.-Colonel Cunningham, R.E.—On the Calculation of the Sum of the mth Powers of a Large Number of Magnitudes: W. F. Sheppard.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—On the Manufacture of Lamps and other Apparatus for 200 volt Circuits: G. Binswanger-Byng.

FRIDAY, MARCH 11.

ROYAL INSTITUTION, at 9.—Marked Unexplored: W. F. Lord.

ROYAL ASTRONOMICAL SOCIETY, at 8.—On a convenient Method of Adjusting a Polar Axis to the Diurnal Motion: D. P. Todd.—Nebulæ discovered at the Royal Observatory, Cape of Good Hope: Royal Observatory, Cape of Good Hope.—List No. 7 of new Nebulæ: L. Swift.—Long enduring Spots on Jupiter: A. S. Williams.—The Concave Grating for Stellar Photography: C. L. Poor.—On the Fallacy Associated with the Current Rotation Periods of Venus: E. M. Antoniadi.—Equatorial Comparisons of Neptune with 114 Tauri: J. Tebbutt.—A Remarkable Object in Perseus: Rev. T. E. Espin.—On the "Two Method" Personal Equation: W. W. Bryant.—A few Suggestions with Reference to the Newtonian Reflector: T. W. Bush.—The Spectrum of o Ceti, as Photographed at the Stonyhurst College Observatory: Rev. W. Sidgreaves.—The Effect of Latitude Variation on the Ecliptic Investigation: W. G. Thackeray.—Note on Dr. Gill's Paper on the Effect of Chromatic Dispersion of the Atmosphere on the Parallaxes of α Centauri and β Orionis: Prof. A. A. Rambaut.

PHYSICAL SOCIETY, at 4.—Council Meeting.——At 5.—On Dynamical Illustrations of certain Optical Phenomena: Prof. J. D. Everett, F.R.S.—On Properties of Liquid Mixtures: R. A. Lehfeldt.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Drainage of Cottage Property: H. C. Adams.

MALACOLOGICAL SOCIETY, at 8.—The Mollusca of Lake Tanganyika, with especial reference to their Origin and Affinities: J. E. S. Moore.—On the Anatomy of *Mulleria* and *Mutela*: M. F. Woodward.

MONDAY, MARCH 14.

SOCIETY OF ARTS, at 8.—The Thermo-Chemistry of the Bessemer Process: Prof. W. N. Hartley, F.R.S.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploration in Spitsbergen, 1897: Sir W. Martin Conway.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Electrical Industries at the Foyers Waterfalls: R. W. Wallace.

TUESDAY, MARCH 15.

ROYAL INSTITUTION, at 3.—The Simplest Living Things: Prof. E. Ray Lankester, F.R.S.

SOCIETY OF ARTS (Foreign and Colonial Section), at 4.30.—The West Indies and Sugar Bounties: Nevile Lubbock.

ZOOLOGICAL SOCIETY, at 8.30.—On New or Imperfectly Known Species of Ostracoda, chiefly from New Zealand: Dr. G. Stewardson Brady, F.R.S.—On a New Flagellate Protozoan of the Genus *Lophomonas*: E. H. J. Schuster.—On the Early Post-Larval Stages of the Crab (*Cancer pagurus*), and on the Affinity of that Species with *Atelecyclus heterodon*: J. T. Cunningham.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Calcium Carbide and Acetylene: Henry Fowler.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Half-tone Negative-making: W. H. Lascelles.

ROYAL VICTORIA HALL, at 8.30.—Wireless Telegraphy: A. W. Porter.

ROYAL STATISTICAL SOCIETY, at 5.

WEDNESDAY, MARCH 16.

SOCIETY OF ARTS, at 8.—The Recent History of Paper-making: Clayton Beadle.

ROYAL GEOGRAPHICAL SOCIETY, at 4.30.—Sea Beaches and Sand Banks: Vaughan Cornish.

ENTOMOLOGICAL SOCIETY, at 8.—Further Notes on Dyscritina, Westw.: E. E. Green.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Photographing Meteorological Phenomena: Arthur W. Clayden.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Exhibition of Mounted Rotifers: G. F. Rousselet.

THURSDAY, MARCH 17.

ROYAL SOCIETY, at 4.30.—The Croomian Lecture will be delivered by Prof. Wilhelm Pfeffer, For. Mem. R.S. On the Nature and Significance of Functional Metabolism (Betriebs-stoffwechsels) in the Plant.

ROYAL INSTITUTION, at 3.—Magnetism and Diamagnetism: Prof. J. A. Fleming, F.R.S.

LINNEAN SOCIETY, at 8.—Natural Selection the Cause of Mimetic Resemblance and Common Warning Colours: Prof. E. B. Poulton, F.R.S.—On the Brain of the Edentata, including Chlamydophorus: Dr. Elliott Smith.—On Limnocarpus, a New Genus of Fossil Plants from the Tertiary Deposits of Hampshire: Clement Reid.

CHEMICAL SOCIETY, at 8.—The Reduction of Bromic Acid and the Law of Mass Action: Winifred Judson and Dr. J. Wallace Walker.—The Action of Ferric Chloride on the Ethereal Salts of Ketone Acids:—Dr. R. S. Morell and Dr. J. M. Crofts.—Note on the Volatility of Sulphur: T. C. Porter.—Action of Ammonia and Substituted Ammonias on Acetylurethane: Dr. George Young and Ernest Clark.—Cannabinol: T. B. Wood, W. T. N. Spivey, and Dr T. H. Easterfield.—Formation of Oxytriazoles from Semicarbazides: Dr. G. Young, and B. M. Stockwell.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Sixth "James Forrest" Lecture, Geology in Relation to Engineering: Prof. W. Boyd Dawkins, F.R.S.

CAMERA CLUB, at 8.15.—Some Recent Animal Photographs: Gambier Bolton.

FRIDAY, MARCH 18.

ROYAL INSTITUTION, at 9.—The Bringing of Water to Birmingham fro the Welsh Mountains: J. Mansergh.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

BOOKS.—Peregrinazioni Antropologische e Fisiche, &c.: Dr. T. Vignoli and Prof. G. V. Schiaparelli (Milano, Hoepli).—Travels in the Coastlands of British East Africa &c.: W. W. A. Fitzgerald (Chapman).—L'Algérie: J. A. Battandier and L. Trabut (Paris, Baillière).—Epidemic Diphtheria: Dr. A. Newsholme (Sonnenschein)—Magnetical and Meteorological Observations made at the Government Observatory, Bombay, 1896 (Bombay).—Geological Literature added to the Geological Society's Library during the Year ended December 31, 1897 (Geological Society).—Royal Geographical Society. Year-Book and Record, 1898 (Royal Geographical Society).—La Photographie et l'Étude des Nuages: J. Boyer (Paris, C. Mendel).—The Teacher's Manual of Object-Lessons in Domestic Economy, V. T. Murché: Vol. 1 (Macmillan).—General Elementary Science (Clive).

PAMPHLET.—Review of Mineral Production in India for 1896 (Calcutta).

SERIALS.—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1898, No. 1 (Bruxelles)—Journal of the Royal Microscopical Society, February (Williams).—Zeitschrift für Physikalische Chemie, xxv. Band, 2 Heft (Leipzig, Engelmann).—Middlesex Hospital Journal, Vol. 2, No. 6 (London).—Quarterly Journal of the Geological Society, February (Longmans).—Journal of Botany, March (West).—Scribner's Magazine, March (Low).—Archives de Parasitologie, January (Paris, Carré).—Revue de l'Université de Bruxelles, March (Bruxelles).—National Review, March (Arnold).—Fortnightly Review, March (Chapman).—National Geographic Magazine, February (Washington).—Transactions of the American Microscopical Society, December (Buffalo).—Geographical Journal, March (Stanford).—Astrophysical Journal, February (Chicago).—Atlantic Monthly, March (Gay).

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THURSDAY, MARCH 17, 1898.

THE CHEMISTRY OF THE METALS.

A Treatise on Chemistry. By H. E. Roscoe and C. Schorlemmer. Vol. ii. The Metals. New edition completely revised by Sir H. E. Roscoe, assisted by Drs. H. G. Colman and A. Harden. Pp. 1192. (London: Macmillan and Co., Ltd., 1897.)

NEARLY twenty years have elapsed since the appearance of this part of Roscoe and Schorlemmer's well-known treatise, and as in the interval much important work has been done in connection with the classification of the elements, with metallurgical processes, with chemical manufactures and new theories bearing upon our views of the constitution of salts, the condition of dissolved substances and other important questions have been proposed, it is obvious that the time has come when a new edition is urgently needed. It may at once be said that the revision has been accomplished with great care, with full knowledge, and, speaking generally, with a great measure of success.

The introductory chapters, which occupy 150 pages, naturally contain the most debateable matters, concerning which, probably, there will always be considerable differences of opinion, relating as they do to such subjects as the characteristics of metals, to valency, to classification and other subjects which are less matters of fact—for there is usually not much dispute about the facts—than of inference, and must therefore assume different aspects according to the degree of importance with which they are invested in different minds.

Take, for example, the consideration of those properties of the metals which seem to some people to mark off these substances very clearly from the remaining elements, which are commonly referred to as non-metals. Of course any attempt to arrange natural things into groups, the members of every one of which are distinguishable sharply from the members of other groups, fails hopelessly when such attempt is carried too far; but this need not prevent such attempts from reaching that measure of partial success which is practically useful. It is, in fact, impossible to avoid classification, for no sooner does a series of facts or phenomena become known than the mind involuntarily proceeds to arrange them into groups, and the pretence on the part of a few modern chemists that *no* scientific distinction can be drawn between metals and non-metals is not likely to be permanently maintained. The want of definiteness on this point in the book before us is to be regretted. We are told (pp. 5, 6) that "although the division into metals and non-metals is thus seen to be one which does not admit of exact definition, it is none the less true that the metals as a class do possess certain generic properties which the non-metals either do not possess at all or exhibit only in a very slight degree," and it is a little surprising to find that "among these properties that of metallic lustre may be specially mentioned." What then about iodine, graphite and tellurium, which most people agree to place among non-metals?

Undoubtedly any attempt to provide a definition which shall be comprehensive enough to include not only the seven ancient metals, but such things as arsenic, antimony, titanium, as well as the true metals—sodium and the rest which have been made known in modern times—must fail; but that is not a reason for refusing to recognise in the great majority of those elements which show a disposition to form oxides of more or less pronounced basic character, certain other characters, chemical and physical, which, taken together, afford a useful criterion of the true metal, while for those elements which only imitate the metals in one character or more and fail in the rest, the term "metalloid," so long misapplied, might be appropriately retained. The true metal is malleable, with a good conducting power for heat and electricity, and forms no gaseous or vaporisable compound with hydrogen. The semi-metal or metalloid is brittle, a bad conductor, and in many cases produces a gaseous hydride.

The general adoption of Mendeléeff's scheme of classification of the elements has no doubt served to increase the difficulty felt as to the distinction of metal from non-metal; but even in the periodic table the non-metals are confined to the top right-hand corner, and display amid great physical diversity an assemblage of chemical characters which marks them off as a class.

Naturally there are elements which recall in respect to one set of relations the features of a metal, and in respect to another those of a non-metal, and these of course stand between; but to refuse to recognise these distinctions would be as inconvenient as a proposal to do without "orders" in botany because all botanists are not agreed about the diagnostic characters of every order in the vegetable world.

The authors have made a change of some importance in the sequence in which the metallic elements are taken for study in this volume. In the first edition they were grouped into families more or less entitled to be regarded as "natural"; but are now taken in the order of the periodic system. There is, however, a sort of acknowledgment of the inconvenience of this plan for the arrangement of matters for study, inasmuch as it is departed from at the very outset, sodium and not lithium being the metal first described. It must, however, be admitted that the authors have dealt with this difficult question in the liberal spirit proper to scientific men. They point out that while the arrangement of the elements in the order of their atomic weights has brought into view the remarkable relations among their properties which are formulated in the so-called "periodic law," and that this system stands upon a very firm basis of fact,

> "the system will doubtless undergo modification as our knowledge increases, for difficulties occur which cannot at present be explained. Thus elements sometimes occur in the same group between which only a limited amount of analogy can be traced and, on the other hand, elements which have a good deal in common are sometimes separated widely."

This being admitted, it is a very doubtful advantage to have adopted the system, interesting and suggestive as it is, as the order for the contents of the book. This, however, is not of serious consequence inasmuch as the

volume is provided with a good index, and old-fashioned people who might be disposed to look for copper, silver and gold elsewhere will have no difficulty in finding a good and clear account of them, notwithstanding that they are sandwiched in between the metals of the alkalis and the metals of the alkaline earths.

The volume concludes with the history of those two remarkable substances argon and helium, and winds up by pointing out that "the existence of two substances having the properties of argon and helium is not in any way indicated in the periodic classification of the elements, and it is probable that their discovery will lead to modifications of that hypothesis," a statement with which even the most fanatical of periodic chemists will find it difficult to disagree.

One is tempted to think that, if we were not so familiar with it, *hydrogen* is the element upon which, in connection with any system of classification, wonder must be concentrated. Undoubtedly a positive element, similar in general chemical character to a metal, yet its volatility removes it far from any acknowledged metal, and its low atomic weight separates it in the periodic scheme from all the other gaseous elements. Its nearest allies are the metals of the alkalis, and towards them it stands, so far as physical character is concerned, much in the same relation as nitrogen to arsenic and antimony or oxygen to selenium and tellurium. And even as to chemical relations its position is analogous to that of nitrogen or of oxygen, notwithstanding that among the negative elements chemical activity generally diminishes as atomic weight increases; while in the series Li, Na, K, Rb, Cs, chemical activity increases with atomic weight.

The question of the molecular weights of the metals is one of great interest. It has been known for a long time, from the vapour densities of mercury, cadmium, and zinc, that the molecules of these metals are monatomic, while the semi-metal arsenic forms in the state of vapour a molecule composed of four atoms. Potassium and sodium are unmanageable, and no other metal is volatile enough to afford by this process any trustworthy results. But attempts have been made to estimate the molecular weights of a great many metals by observation of the depression of the freezing points of certain fusible metals—for example, of tin, lead, or bismuth (Heycock and Neville), or of the lowering of the vapour pressure of mercury (Ramsay) by solution in these fluids of determinate quantities of the metals under consideration. The general result of these experiments tends to the conclusion that in nearly all such cases the molecules are composed of one atom only. There is evidently room for further experimental inquiry in this direction, for there seems at present to be some conflict of testimony. The molecule of arsenic in the vaporous state is undoubtedly As_4, and its chief oxide is also admittedly As_4O_6. In like manner the molecule of antimonious oxide is Sb_4O_6, and by analogy one must conclude that the vapour of antimony, although not actually observable, must be tetratomic or Sb_4. When these vapours condense, either to the liquid or solid state, it would be contrary to all experience in other cases to suppose that they dissociate, and that the four atoms part company from each other. Yet this is what the results derived from freezing point or vapour pressure experiments would lead to. There is also the curious fact that the theory of Dulong and Petit, which states that specific heat in the solid elements is inversely as the *atomic* weight, points to the atom, and not any congeries of atoms, as the physical unit in the solid. So that, for example, arsenic and cadmium, so different as regards vapour density, agree in atomic heat; thus—

	Specific Heat ×	Atomic Weight	= Atomic Heat
Arsenic	·0814 (Regnault)	74·4	= 6·05
Cadmium	·0542 (Kopp)	111·3	= 6·03

Probably in the solid the molecules settle down into some tactical relation to one another, in consequence of which the atoms of neighbouring molecules are brought as near together by cohesion as the atoms in any one molecule are by chemical attraction.

Turning again to the volume before us, there is much that must be interesting to readers of all classes, and especially in connection with the metallurgy of such metals as sodium and aluminium, concerning which Sir Henry Roscoe is in a position to give trustworthy information. As is well known, sodium was first obtained in 1807 by Sir Humphry Davy, who got it by the electrolysis of caustic soda. Subsequently Gay-Lussac and Thénard succeeded in decomposing that compound by means of metallic iron at a high temperature, but up to quite recent times it has been usual to manufacture it by distilling a mixture of dry sodium carbonate and charcoal, the metal passing over accompanied by the escaping carbonic oxide. But even in well-conducted operations the yield of metal corresponded to not more than about one-third of the theoretical amount.

A great improvement was introduced by Mr. Castner some fifteen years ago when he replaced sodium carbonate by caustic soda, and employed an intimate mixture of iron and carbon as the reducing agent. It is now interesting to learn that he has accomplished another great advance which consists in adapting the original method to manufacturing purposes, and we are told that whereas—

"in the year 1807 Davy, with his battery of 100 cells, found it impossible to produce the effects of decomposition on pieces of soda of more than fifteen or twenty grains in weight, the process has now been so amended that the plant at the works of the Aluminium Company, Limited, at Oldbury, manufactures about five tons of sodium per week."

What becomes of so large a quantity of this strange metal, considering that the Aluminium Company no longer makes aluminium, and sodium is no longer used for this purpose anywhere, is a question which naturally arises. And the answer is supplied pretty well by the book. Sodium is used for the manufacture of cyanides, the consumption of which in the process of extracting gold from poor ores and tailings must be now enormous. It is also used for the manufacture of sodium peroxide, for the production of metallic magnesium, and in the preparation of certain complex carbon compounds, of which the most important commercially is antipyrine.

The history of the metal aluminium has also many points of interest. The discovery of the metals sodium and potassium by Davy placed in the hands of chemists

new and very powerful agents, by which it became possible to isolate from their compounds several elements the existence of which was well recognised, but which had previously resisted all attempts to obtain them in a separate state. Among these was aluminium, which was seen for the first time in 1828 by Wöhler, who succeeded in decomposing the chloride by potassium. With the substitution of the cheaper sodium for potassium, and the occasional replacement of the chloride by the fluoride of aluminium, this was practically the method adopted by the experimentalist and manufacturer alike down to quite recent years. The Aluminium Company, already referred to, was formed for the purpose of working such a process with the use of sodium obtained more abundantly and cheaply than before by Castner's process. All this is now changed. So long ago as 1854 aluminium was deposited in the metallic state by the electrolysis of the fused chloride of aluminium and sodium according to the method introduced by Bunsen. It was also stated to have been obtained by the electrolysis of aqueous solutions of certain aluminium compounds, but this appears to have been a mistake. The method now adopted consists in subjecting to the electric current pure alumina in a fluid state, that is fused alone or dissolved in melted cryolite.

Now that the energy of falling water is being turned to account on a large scale, works have been established at Neuhausen near the falls of the Rhine, at Niagara, and at Foyers in Scotland, for the production of the current by means of vast dynamo machines, and its application, among other chemical manufactures, to the reduction of aluminium.

Little else remains to be said of the book except by way of commendation. A few minor matters have been passed over rather slightly. Thus the solubility of calcium sulphate in water containing chlorides is a matter of some importance from a technical point of view; and the simple statement of the text (p. 437), that "according to Anton 1 part of gypsum dissolves in 122 parts of a saturated solution of sodium chloride," is neither very precise, nor is it of much practical use. A long series of determinations of the solubility of calcium sulphate in chlorides is provided by the work of Lunge (*J. Soc. Chem. Ind.*, 4, 31), and by that of Tilden and Shenstone (*Proc. R. S.*, 38, 331). As regards the temperatures supposed to be indicated by the colours developed upon the surface of steel in the process of tempering, it has been shown, more especially by Turner, that these colours can be *successively* developed by protracted heating to the same temperature, and under any circumstances are not to be interpreted to within a considerable range of degrees. As the interesting lead tetrachloride has been properly mentioned, the more stable tetracetate (Hutchinson and Pollard) should have been noticed at the same place.

The whole of such a volume as this should be read attentively by every serious student of chemistry; and if this treatise does not displace all other English text-books devoted to mere description, it will be solely on account of the unfortunate but unavoidable high price, a consideration which necessarily influences so many students in their choice.

W. A. T.

SUBMARINE CABLE TESTING.

Student's Guide to Submarine Cable-Testing. By H. K. C. Fisher and J. C. H. Darby. Pp. 165. (London: *The Electrician* Printing and Publishing Co., 1897.)

THIS practical and useful little book is designed as its title indicates, and, as its authors state in their preface, to meet the requirements of young students in this particular branch of submarine cable engineering, and to endeavour to place before them in as concise and lucid a manner as possible, not only the practical problems involved in the study of cable-testing, but also the simple algebraical formulæ necessary for their solution.

Many of the large submarine cable companies now demand that their employés shall qualify themselves in electrical subjects, and shall pass certain examinations before being considered eligible for promotion from the lower to the higher grades of the service.

This very proper requirement on the part of the companies has resulted in stimulating their staffs to greater exertions; but it has been found that the ordinary text-books in circulation are either too theoretical and advanced for beginners, or fail to deal with and thoroughly explain just those particular points upon which they seek instruction.

The authors of the little work under review—practical electricians and cable engineers themselves—were constantly being asked for information upon these points, and their first effort to meet this demand upon their time and patience took the form of a small pamphlet entitled "Notes on Practical Cable-Testing," of which a small number was printed and issued privately.

This first effort was so far appreciated, as to encourage them to hope that a more ambitious work, carried out on the same lines, might be found still more useful; and although, as the authors modestly remark in their preface, "the scope of the present work is bounded by the requirements of the electrical examinations for supervisors, and the ordinary electrical outfit of all the company's stations," we venture to think they have so far succeeded in their purpose, that this book will be found of practical value, not only to those for whom it was originally written, but to all desirous of studying and understanding this most interesting subject.

As we have already observed, too many of the existing text-books are the works of theorists who do not concern themselves with the practical features of the matters upon which they write; in fact, who do not possess the necessary practical experience themselves, which would enable them to do so satisfactorily; and we think, therefore, that this little book will be accepted, and rightly so, as a useful contribution not only to our knowledge, but also to submarine cable bibliography.

The work is divided into two parts: the first dealing with simple testing, such as the measurements of resistances and of electrostatic capacity, together with the testing of batteries for electromotive force and interna resistance; and the second, with the various known methods which are adopted for the localisation of faults in submarine cables.

In a book of this description it would be invidious to criticise too closely, or we might be tempted to question some of the definitions of terms in the opening chapter, such as "Farad—the practical unit of capacity" and "Shunt—a conductor, usually a resistance box, for leading into another channel part of a current that is too powerful for the immediate purpose."

The idea, however, seems to have been to convey to the reader the practical sense of things, and not to split hairs as to choice of terms. The chapter on that electrical *pons asinorum*, the theory of the Wheatstone Bridge, is especially clear and well put, and the student who reads and digests it thoroughly may cease to frown at the name of Kirchhoff, the sum of whose quantities has frequently an aggravating habit to the student mind, of equalling nothing.

Paragraphs 54–55, pp. 55–59, explaining the necessity for ascertaining the proper time constants to be allowed in charging long cables, whose resistances it is required to measure, are very important to learners, and should be carefully studied. Three simple rules are given for determining these constants in the cases of (1) a perfect cable, (2) a broken cable, and (3) a faulty cable, and it is suggested that an ordinary metronome, such as is used in beating time for music, will be found of great assistance in measuring the time for charging and discharging.

Articles have recently appeared in the technical journals, and some discussion has followed, upon the relative merits of the "scale zero" as opposed to the "false zero" method, for fault localisation especially. Upon this head the authors remark: "We will now describe the 'false zero' method. We consider this method by far the best and most accurate . . . especially with a faulty cable"; and again at p. 54, with special reference to Mance's method for eliminating the resistance effect of an earth current, they observe: "It may be pointed out here that the statement that R, the resistance equivalent to the E.C. varies inversely as *c*, the current to line, is not quite correct in the case of faulty cables. If the testing current be reduced or increased, it slightly *reduces* or *increases* the E.M.F. due to *polarisation of the fault*, and therefore the current set up thereby, but we have not found this error to be as a rule appreciable."

The tests for the measurement of capacity are clearly explained as far as they go, and numerous references are given to various text-books and other publications, to enable the student to follow out for himself the study of the effect of the phenomenon of absorption upon different dielectrics.

In the second part of the book, a description of the various tests employed for localising partial faults, and total breaks in submarine cables, is prefaced by a few interesting preliminary remarks upon the nature of these faults, and their behaviour under the influence of the testing current.

It is interesting also, and instructive, to note the headings under which they are grouped, such as those due to submarine borers, to chemical action, *fish-bites*, punctures, &c.

We must, however, take exception to the expression "Kennelly's law" in the description of his tests for total breaks. A "law" in this sense must be absolute and unchangeable, whereas Kennelly's "*rule*" that "when the exposed area of a break s constant, its resistance varies inversely as the square root of the current strengths passing through it" is only true between certain limits of current. Kennelly pointed this out himself, and Schaefer has since demonstrated that beyond 25, and up to 50 milli-amperes, the resistance varies inversely as the 1·3th root of the current strengths.

The authors have endeavoured to make the various sections of their book complete in themselves, and have added a number of diagrams of connections for signalling on cables, which form a new feature in works of this description, and which, with the various tables of temperature coefficients, will no doubt be found useful.

We may add that nearly all the examples are actual tests of cables, and are given very fully in the hope that they may tend to throw a practical light upon the explanations of the various tests.

In conclusion, we feel it incumbent upon us to recommend every student of submarine cable engineering to add this little volume to his library.

BRITISH MOTHS, AND THE GENUS DIANTHŒCIA.

The Lepidoptera of the British Islands. A Descriptive Account of the Families, Genera and Species indigenous to Great Britain and Ireland, their Preparatory States, Habits and Localities. By Charles G. Barrett, F.E.S. Vol. iv. Heterocera. Noctuæ. 8vo, pp. 402. (London: Reeve, 1897.)

THE fourth volume of Mr. Barrett's elaborate work includes ninety-eight species (three of which, however, are regarded by the author as doubtfully British) distributed among thirty genera of the *Noctuæ Trifidæ*, to which group belong by far the larger part of the European stout-bodied, night-flying moths. This gives us an average of something like four pages to each species, though many of the notices run to six or seven pages; and on such a scale it will require twenty volumes to complete the life-histories of our British Lepidoptera.

Mr. Barrett is well known as one of the best of our practical entomologists, and the history of every species is worked out with extreme care, the observations of numerous lepidopterists throughout the British Isles being freely utilised, in addition to those of the author himself. The foreign range of each species is also briefly indicated, though the character and extent of the book prevents almost any allusion to allied species not occurring in Britain, except so far as such notices are absolutely necessary to elucidate British species.

Considerable space is devoted to the genus *Dianthœcia*, which includes eight or nine British species, most of which are coast-frequenting insects with us, the moths being found flying over *Silene* in the evening, often on precipitous sea-cliffs, where it is not unfrequently a task of some difficulty and danger to capture them. The larvæ are described by Mr. Barrett as "smooth, plump, with the head small, usually feeding on or in the blossoms or seed-vessels of plants belonging to the *Caryophyllaceæ*."

Britain is called by the French entomologists, *le pays de variétés*; and the British species of *Dianthœcia* are

extremely variable with us, especially in outlying parts of our islands, where isolation tends to encourage variation. Mr. Barrett's account of the variation of *D. conspersa*, Esper, an unusually widely-distributed species with us, is well worthy of the attention of scientific naturalists, and alone furnishes a sufficient reply to any persons who may imagine that our British Lepidoptera may be regarded as worked out. These notes are too long to reproduce in their entirety, as they extend to nearly two pages; but we may perhaps be allowed to quote a few sentences relative to the variations exhibited by *D. conspersa* in the Scottish islands, the entomology of which has only been systematically investigated within the last twenty years or so.

"It is in the Shetland Isles that the most extraordinary forms are found—the white markings utterly suppressed, or the stigmata alone white, or yellow, or pale ochreous, or black-brown and only indicated by blacker margins; the subterminal line only indicated by its attendant black clouds, and sometimes the whole surface of the fore-wings smoky-black or olive-black, with but a faint dappling of blacker lines and crescents; on the other hand, some specimens in these islands are of the form in which the ground colour is intensified, but the markings, though curtailed, sharply white. This last form is also found in the West of Ireland, and a specimen now before me from Sligo is singularly rich in its deep dark colour and snowy blotches. Specimens from the Hebrides are extremely beautiful, the white markings variegated with yellow and greenish-yellow, or even orange-yellow. Those from Orkney are somewhat similar, or with the white markings small but clear. Although there are so many apparently local strains of variation, all are intimately connected by intermediates, so that, except in some degree in Shetland, it is impossible definitely to separate the species into varieties. . . . Mr. McArthur, who has collected very extensively in [the Shetland] Islands, assures me that the darkest suffused and nearly unicolorous forms are found mainly on the East coasts, more particularly of the island of Unst, where the rocks among which the food-plant grows are of a very dark colour; while on the West coast, where the rocks are of a paler colour, the forms found are more nearly normal, with intermediate varieties. Also that in the Hebrides, along with rocks ornamented with yellow lichens, he has found those varieties of the moth having an orange- or olive-yellow tinge. This is the more remarkable in that the moth does not appear there to sit upon the rocks, or to give up its usual habit of hiding in the daytime among herbage."

Another very interesting species of the same genus is *Dianthœcia Barrettii*, Doubleday, which was originally captured by Mr. Barrett at the Bailey Lighthouse at the Hill of Howth, near Dublin. It has scarcely been taken anywhere but on this hill, except singly at the Land's End, Ilfracombe, Tenby, Carnarvonshire, and perhaps in the south of Ireland. Mr. Barrett, in common with several other lepidopterists, now regards it as a variety of the continental *Dianthœcia luteago*, Hübner, remarking: "There is at first sight no resemblance between them, yet, with the exception of the colour, no distinction of any importance can be found." In the larva the spiracles are said to be black in *D. Barrettii*, and flesh-coloured, encircled with black in *D. luteago*.

But before the identity of the two forms can be taken as established, broods of each should be reared in different larva-cages by the same observer, and the differences between them carefully noted at each stage. It may be that *D. Barrettii* is only an incipient species at present; but it is equally probable that further observation may show that it is abundantly distinct from *D. luteago*. We incline to think that it is a little premature to class the two forms together, even tentatively, without better evidence.

We hope that Mr. Barrett will succeed in completing the great work on which he has now made such good progress, and which is likely to remain a most valuable record for all time of the state of our knowledge of the British Lepidoptera at the end of the present century. We cannot speak of the plates, as we have only the smaller edition, without illustrations, before us while writing.

W. F. KIRBY.

OUR BOOK SHELF.

A Suggested Improvement of the Current Theories of the Tides. By J. H. S. Moxly. Pp. 43. (London: Rivingtons, 1898.)

IN this brochure, Mr. Moxly expresses his dissatisfaction with the theory of the tides, as ordinarily accepted, and submits an alternative explanation. Although he opposes the views generally held, he does not exhibit that spirit of antagonism and adopt the language of abuse that too frequently disfigures the writings of those who dissent from authoritative teaching. Where it has been necessary to refer to the papers of Airy or of Darwin, these names are generally mentioned with the respect due to their great reputation, and therefore, though we are as thoroughly opposed to Mr. Moxly as he is to the mathematicians just mentioned, we shall endeavour to adopt the same courtesy towards him that he has shown towards others.

The author considers that the tides are heaved up by the earth's gravity. The differential attraction of the sun and moon simply gives an opportunity for the earth's gravity to display itself in this manner. This action is illustrated by reference to a football. When the leathern covering is injured, or a seam gives way, the inner india-rubber case bulges out through the opening in the outer cover. "The pressure of the outer case had been removed from one region of the ball, and the pressure of the part which remained did the rest. This, I take it, is exactly how the pressure of the earth's gravity produces the tide." We are all prepared to admit with the author, that the tide-raising force is directly opposed to the action of the earth's gravity, though we might not adopt his phraseology. But another elementary proposition shows that the tide-raising force varies inversely as the cube of the distance of the disturbing body, and we fail to derive this from the football illustration, or from anything directly asserted in the pamphlet, though we notice that some mathematical formulæ are quoted in which the third power of the disturbing force is given. Moreover, by another illustration drawn from the observation of pressure applied to a water-bed, the author concludes that the crest of the tidal wave will always be directly under the moon. We understand this to apply to a uniformly ocean-covered earth. From this it is to be gathered that Mr. Moxly does not consider that the angular distance between the tidal crest and the moon is a function of the depth of the ocean, which in the wave theory of the tides it clearly should be.

But the test of the accuracy of a theory must at last rest in the comparison of its results with those of observation. Mr. Moxly admits this, and therefore a considerable part of the pamphlet is devoted to showing that his theory explains observed facts. Unfortunately,

we are not able to follow the author very clearly in this part of his treatise; but so far as can be seen, the conclusions are inadequate. For instance, the tide at Kerguelen is triumphantly pointed to as proving the coincidence of the tidal crest with the moon's passage over the meridian; but there is no reference to Fiji, where the tide lags some six hours, and the conditions for observation appear equally favourable. We do not propose to follow the author in his discussion of such niceties as the diurnal tide, and prediction for a particular port. If any other remark be needed to indicate the character of the work, it will be found on p. 40: "the swaying of the axis of the tidal spheroid about the axis of the earth's rotation gives us a clear explanation of the production of the phenomenon of nutation."

A Practical Physiology: a Text-Book for Higher Schools. By Albert F. Blaisdell, M.D. Pp. vi + 448. (Boston, U.S.A., and London: Ginn and Co., 1897.)

THIS is not a handbook for the physiological laboratory, but a school lesson-book on elementary anatomy, physiology, hygiene, nursing, and ambulance work. A manual of this kind can hardly be otherwise than superficial, but the information it contains ought to be accurate as far as it goes. In the present case, however, signs of carelessness abound throughout; and the teaching, when not absolutely erroneous, is often misleading. A few instances will suffice to give an idea of the traps which await the unwary student of these pages. Peyer's patches are stated by implication to consist of glands which secrete intestinal fluids. In a figure representing the heart and great vessels, the innominate artery is called the "right subclavian," the left common carotid appears as the "right common carotid," and the left subclavian is labelled the "left common carotid." In a diagram intended to illustrate intestinal absorption, the veins of the mesentery are represented as inosculating with the lacteals. "The power which the pancreatic juice possesses of acting on *all* the food-stuffs appears," it is asserted, "to be due mainly to the presence of a specific element or ferment known as *trypsin*." It is impressed on the student that he should learn how to tie a "reef" knot. But in the figure given to illustrate the directions of the text (which are correct), the author has delineated an unmistakable "granny." After these specimens of erroneous and careless treatment of the subject, it is of minor importance to note that in the repeated denunciations of the use of alcohol and tobacco, inserted, as the preface informs us, in compliance with the laws of most of the States, little or no attempt is made to distinguish between the effects of ordinary and toxic doses of these substances. A book like the present is far more likely to retard than to advance the cause of elementary physiological teaching in schools. F. A. D.

Die Photographische Praxis. Part i. By Prof. H. W. Vogel. (Berlin: Gustav Schmidt, 1897.)

OUR first words must be to congratulate Prof. Vogel that he has recovered from the illness that has delayed for three years the completion of this section of the new edition of his "Handbuch der Photographie." The part now issued is the first part of the third volume, and deals with photographic studios and apparatus (excluding lenses, which are treated of in a previous volume) and the negative processes with collodion and with gelatine emulsions. The chief differences between this and the previous edition are that the practice of photography is now regarded from a general rather than from a merely "professional" point of view, portable apparatus and shutters being considered, and that chapters are given on the use of colour sensitised plates and film photography. Collodion, on account of its continued application in the reproduction processes, retains the premier position; gelatine following with about the same number of pages devoted to it. Considering the space given to the various branches of the subject, it is surprising that some of the most important advances made during the last ten years or so are not represented. We refer to advances of immediate practical importance, such as the methods of determining the exposure required, recent methods of determining the sensitiveness of plates, and the efficiency of shutters. Intensification also is dealt with in a very inadequate manner. But looking at the volume as a whole, it is a valuable addition to photographic literature, and the opinions and preferences of its distinguished author must always be of interest to English students.

The Miner's Arithmetic and Mensuration. By Henry Davies. Pp. x + 316. (London: Chapman and Hall, Ltd., 1898.)

THIS little volume comprises a collection of questions in arithmetic, the larger number of which are purely and simply arithmetical, ranging from compound addition to cube roots, whilst a smaller number illustrate the mode of solving some of the simpler numerical problems with which the miner has to deal. The work is naturally more or less elementary, and the formulæ given appear to be in most cases fairly correct; in some instances, however, as in the formulæ given under the head of "the barometer," simplicity has been gained only at the expense of accuracy.

The book seems well calculated to serve its purpose, that of enabling the miner to learn how to answer some of the easier numerical questions usually set in the mine manager's examination, without requiring from him any particular mental effort. Whether it is, however, upon the whole a good thing that the pupil, as well as his teacher, should have a collection of rule of thumb methods, that tax merely their memories, without appealing at all to their intelligence, is quite another matter.

Inspector-General Sir James Ranald Martin, C.B., F.R.S. By Surgeon-General Sir Joseph Fayrer, Bart., K.C.S.I., LL.D., &c. Pp. xvi + 203; plate i. (London: Innes and Co., 1897.)

THE name of Sir James Ranald Martin is known to few, and the details of his career to still fewer. It is for this reason that the volume before us will be welcomed by all interested in the birth and development of the medical profession, and sanitary science in India. Sir Ranald Martin left sanitary science, in the broadest sense of the term, and the position of the medical officer in India, in positions very different to those in which he found them. It would have been difficult—indeed, impossible—to have found a better biographer than Sir Joseph Fayrer, whose intimate knowledge of all that concerns medicine in India is absolutely unrivalled. So far as we are aware, the *rôle* of biographer is new to Sir Joseph; we can only say that from apparently scanty material he has constructed a biography accurate, interesting and instructive.

The biographer, put shortly, describes Sir Ranald's early life and early work in India, following him through the disastrous Burmah campaign 1824–26. Then follows a record of his public services in India. Amongst these, perhaps, the most striking are the inauguration of a system of medical statistics and the sanitary improvement of Calcutta. In 1840, at the age of forty-four, Sir James Ranald Martin returned to London, and took up his residence in Grosvenor Street. From this onwards, with the exception of some time devoted to literary work, which bore fruit in the shape of his treatise "On the influence of tropical climates on European constitutions," he devoted himself entirely to administrative work in connection with medicine and sanitary reform in India. His services in this direction met with but tardy public recognition, for it was not until 1860, sixteen years

before his death, that he obtained his C.B. and knighthood. His memory has been perpetuated in that branch of the profession which he so adorned by the establishment, at Netley, of the Martin Memorial Gold Medal, which is presented to the surgeon on probation who takes the highest place in military medicine at the final competition. The biography is exceedingly pleasant reading, and the author has done well to incorporate in it letters from many interesting persons to Sir Ranald, and also some extracts from official documents, in the compilation of which he was concerned. F. W. T.

The Chemistry of the Garden: a Primer for Amateurs and Young Gardeners. By Herbert H. Cousins, M.A. Pp. xv + 141. (London: Macmillan and Co., Ltd., 1898.)

THIS little book is very clearly and pleasantly written. It contains much valuable practical information respecting garden soils, the use of artificial manures in horticulture, the preparation and application of effective fungicides and insecticides, and various other matters. The book is designed for the use of persons who have not received a scientific education, and we should think it will exactly meet their wants; there is, however, much in it that will well repay the perusal of a higher class of readers. There are a few minor points which seem open to criticism. "Pod-plants" is not a good distinctive name for the *papilionaceæ*, as the *cruciferæ* are also podded. The popular use of the word "germ," as descriptive of certain races of living beings, should surely be discouraged as fundamentally incorrect. Nor is there any advantage gained by speaking of "muriate of potash," though the term still lingers in commerce. If a person who knows nothing is to be taught, it is surely needless to burden him with archaisms which he must unlearn if his education proceeds any further. Agricultural chemists will, we think, demur to the same valuation being applied to the nitrogen of ammonia and to the nitrogen of insoluble organic manures. R. W.

The Naturalist's Directory, 1898. Pp. 125. (London: Upcott Gill, 1898.)

THE sub-title explains that this book is "for the use of students of natural history, and collectors of zoological, botanical, or geological specimens, giving the names and addresses of British and foreign naturalists, natural history agents, societies and field clubs, museums, magazines, &c." The volume is more remarkable for what it omits than for what it includes, and disappointment will be saved by not referring to it for the addresses of well-known naturalists.

The Teacher's Manual of Object-Lessons in Domestic Economy. By Vincent T. Murché. Vol. i. (Standards I. and II.) Pp. 250. (London: Macmillan and Co., 1898.)

THIS manual is, the preface informs us, "designed primarily to meet the requirements of the Education Department in the Class Subject of Domestic Economy, as laid down in the Code for 1897." It will be serviceable to the teacher in indicating what to show, do, and describe during object-lessons on materials used for food, and it contains a large amount of clearly explained and well-arranged facts about common things.

Storm and Sunshine in the Dales. By P. H. Lockwood; with a preface by H. G. Hart. Pp. 94. (London: Elliot Stock, 1898.)

A BOOK containing many personal observations on outdoor nature, expressed simply and sympathetically. The author is a fervent admirer of the natural beauties of Yorkshire dales, and his descriptions may lead others to share his enthusiasm, notwithstanding the fact that the scenes he depicts are mostly "glimpses of the obvious."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Dust Shower.

PARAGRAPHS have recently appeared in several of the daily papers to the effect that a dust storm had been encountered off the west coast of Africa by the mail steamer *Roslyn Castle*, and that the dust had fallen on the deck for 900 miles. I was fortunate enough to secure a sample of this dust, which actually fell on the deck, with the following note affixed:—

"Ship covered with fine red dust off west coast of Africa. Lat. 22·5 N. Long. 17·25 W. February 15, 1898."

"Dust fog encountered with for 900 miles. February 18, 1898."

This dust is extremely fine, and consists chiefly of minute grains of quartz and flakes of brown mica, some of the former being well rounded.

I cannot find any trace of glass or other thing to suggest a volcanic origin to the dust; but it is undoubtedly a very fine sand, in all probability derived from the Sahara, although no mention is made of the direction of the wind when the dust fell.

Although cases of volcanic dust being transported for long distances are fairly frequent, those of sand appear to be less so.

Sir A. Geikie ("Text-Book of Geology," p. 337) mentions two cases of the transportation of sand from the Sahara; in the first instance it fell in the Canaries, in the second it was traced as far as Boulogne-sur-Mer. In the present case the distance of transport is probably greater than the one, and less than the other. C. ST. A. COLES.

The Solution of Quadratic Equations.

IN your issue of February 24 a review appears of "Chambers's Algebra for Schools." Your reviewer concludes with a lament of the probable uselessness of protesting against the method of solving quadratics by "completing the square."

Your reviewer might do something towards removing this "national fetish" if he would explain what method is taught elsewhere, to replace this out-of-date procedure. Before this vigorous onslaught, I feel ashamed to confess that I can recall no general elementary method, that does not depend on the completion of the square.

In my desire to free myself from a possibly antiquated "cult," I am, however, willing to undergo this humiliation, in the hopes that I and others may be brought more on a level with the times. E. CUTHBERT ATKINSON.

Rugby, March 6.

IN answer to Mr. Atkinson's letter, I will explain, as briefly as I can, what appears to me to be the proper way of discussing quadratic equations.

As soon as the pupil can easily factorise such an expression as $x^2 - 5x + 6$ into the product $(x - 2)(x - 3)$, it is not very difficult to make him see that 2 and 3 are the only values of x which make $x^2 - 5x + 6$ equal to zero; or, in other words, that the equation $x^2 - 5x + 6 = 0$ can be solved when the expression on the left hand has been factorised.

It is exceedingly important that the factorising of polynomials and the solution of equations should be treated as cognate, or rather equivalent problems. A quadratic equation should always be reduced to the form $ax^2 + bx + c = 0$: then the expression on the left-hand may be factorised by inspection, or else multiplied by such a quantity that the result can be conveniently expressed as the difference of two squares; $4a$ (that is, four times the coefficient of x^2) will always do, sometimes a smaller number. This should be illustrated by numerical examples: for instance, if the equation is $2x^2 + 3x - 7 = 0$, multiply by 8: then $16x^2 + 24x - 56 = 0$, that is $(4x + 3)^2 - 65 = 0$, and $x = \frac{1}{4}(-3 \pm \sqrt{65})$. When a boy is able to appreciate general formulæ, he may be led to see that

$$4a(ax^2 + bx + c) = (2ax + b)^2 - (b^2 - 4ac) = (2ax + b)^2 - (\sqrt{b^2 - 4ac})^2$$

and hence to use the "solution by formula" when he cannot find the roots by inspection.

Mr. Atkinson may perhaps say that this method "depends upon completing the square"; this is true in a sense, of course; but the point of view is really different from the "method of completing the square" usually found in text-books. Practically, the usual method is clumsy, and inferior to the solution by formula; and from the theoretical point of view it is objectionable, because it obscures the real nature of the problem. And I feel sure that many teachers and examiners will agree with me in saying that the educational value of the process is practically *nil:* bright boys go on to the general formula, dull ones follow the rule mechanically, and might just as well be drilled in the use of the general formula itself. G. B. MATHEWS.

WEST INDIAN RESOURCES.[1]

AS expert adviser in botanical and agricultural questions to the recent West India Commission, Dr. Morris undertook the preparation of a lengthy report dealing with the economic resources of those Colonies, the causes of whose distress were the subject of investigation. This paper formed Appendix A of the Report of the Commissioners which was issued last autumn, and the praise bestowed on it as an interesting and valuable survey by one who was specially qualified both by general and local knowledge to undertake the task, induced the Secretary of State for the Colonies to rescue it from the oblivion which is the fate of many important papers appearing in Blue Books. Mr. Chamberlain's desire to have it published in a form more accessible and convenient for the public here and in the Colonies, has resulted in its being converted into an independent volume, and now appears as the first number of an Additional Series of the *Kew Bulletin.* For this purpose the work has been revised and enlarged, a full account of the botanical organisation of each Colony, and lists of books and papers containing further information, being added.

After all that has been dinned into our ears for a long time past about the absolute necessity for the Mother Country to assist the sugar-planters by bounties or countervailing duties, it is refreshing to find a book, every page of which contains an unbiased statement of the natural resources of these unfortunate Colonies. As Mr. Thiselton-Dyer states in a prefatory note: "Dr. Morris's residence in the West Indies, his repeated visits to them, and his intimate knowledge of their conditions, have enabled him to produce an account as accurate as it is impartial of their natural and economic resources, which is certainly more complete than anything hitherto available. Why the West Indian Colonies have failed to reach success, and in what direction the path to it lies in the future, can be readily understood by any one who will take the trouble to read these pages."

The Colonies dealt with have an area about equal to that of Great Britain and Ireland, with the population of Wales. Out of the entire area little more than 2 per cent. is now under cultivation, and only 7 per cent. of the estimated cultivable area. In fact, while about a million and a half acres are being cultivated, over twenty million acres more are suitable for bearing crops. Guiana has an extent of country equal to two Ceylons quite untouched; Trinidad has the wealth of the Straits Settlements going to waste; and the unworked soils of Jamaica could be made to produce the prosperity of at least four Colonies the size of Mauritius. As is well known, the Colonies have long depended almost wholly on the sugar trade as the staple industry, everything else being unworthy of consideration by the planters. Minerals are of comparatively trifling value, being limited practically to gold in Guiana and pitch in Trinidad. Essentially the true wealth of the colonists lies in the products and resources of the rich and fertile soil. In some of the islands it has of late years been recognised that it is as well to be prepared to cultivate more than one kind of produce; but, taken as a whole, we may regard the Colonies as given up to sugar growing, and, as Dr. Morris states:

"In most of the Colonies the situation is undoubtedly aggravated by their almost entire dependence on one industry. This is a source of grave danger in more ways than one. It is dangerous commercially, for any great depreciation of prices immediately affects the whole community. It is dangerous agriculturally, for adverse seasons or hostile tariffs may plunge at any moment the entire labouring population into great distress. Again, the growth of a single crop lends itself sooner or later to the spread of disease, and it rarely leads, owing to the neglect of other resources, to the production of the largest profit. To these may be added the narrowing effects produced on those engaged in the industry, and their inability or disinclination when a crisis comes to take up any other industry."

A dozen chapters are devoted to giving a full account of the past and present of each section of the Colonies—Guiana, Barbados, Trinidad, Tobago, Grenada, St. Lucia, St. Vincent, Dominica, Montserrat, Antigua, St. Kitts-Nevis, and Jamaica. As bearing upon the question of the mistake of relying upon a single industry, Guiana affords us some interesting facts. It is the largest and most valuable of our possessions in the neighbourhood, its capabilities of development are practically unlimited, and yet it is one of the most distressed of the Colonies. The region was ceded to us by the Dutch in 1815, it has an area of 109,000 square miles, a dozen large rivers flowing into the Atlantic, and a population of a little over a quarter of a million, or less than three persons to a square mile. The inland districts are practically uninhabited, nine-tenths of the population clinging to the coast. Under the Dutch sugar, coffee, and cotton were extensively cultivated, but with the transfer to the British Crown the planters gradually concentrated their energies more and more on one article and neglected the others. In 1829 the sugar yield was 46,026 tons, coffee 9,230,486 lb., and cotton 1,596,171 lb. By 1849 the coffee and cotton estates were rapidly disappearing, and in 1887 the returns showed 134,876 tons of sugar, while all other exports had practically ceased. It is this grasping at the most valuable prize, and utterly neglecting all opportunities in other directions, that has led to the downfall of this naturally wealthy country. "The whole activity of British Guiana during the last sixty years has been confined to the narrow strip of land along the coast. In spite of the vast extent of rich and fertile lands in the interior, with the exception of the gold industry, nothing has been done to develop them, and consequently the Colony is now in so critical a condition, owing to its entire dependence on a single industry, that its very existence as a civilised country is in jeopardy." With the knowledge that under another régime coffee and cotton were successfully grown in the district, it would be absurd to suppose, as some contend, that the soil can produce nothing else than sugar. The land devoted to sugar canes is a stiff clay, and fit for little else; but then it forms only the one-thousandth part of the total area of Guiana, and, as Dr. Morris remarks, there is nowhere such an extensive area of rich and fertile lands, with a comparatively healthy climate, and within easy reach of such good markets, as the Crown lands of this district. They can grow nearly every tropical product in demand, either in the New or the Old World.

Suggestions are made and particulars given as to increasing the resources of the country by adding profit-

[1] "A Report on the Agricultural Resources and Requirements of British Guiana and the West India Islands." By D. Morris, C.M.G., M.A., D.Sc., F.L.S., Assistant Director, Royal Gardens, Kew. *Kew Bulletin of Miscellaneous Information*, Additional Series I. Pp. viii + 165, and Map. (London: Eyre and Spottiswoode, Her Majesty's Stationery Office, 1898.)

able industries to the now seriously depressed sugar trade. More than a third of the population is composed of coolies from India, and this explains the importation of 50,000,000 lb. of rice annually; but as the conditions are favourable to the cultivation of rice on the spot, it is surprising that no steps have been taken to establish rice fields, if only for purposes of home consumption. The United States import bananas to the value of two millions sterling annually, but British Guiana makes no attempt to place any fruit on the market, although one shipping company offered to take 10,000 bunches of bananas every fortnight. Coffee, cacao, cocoa-nuts, cattle rearing, and other paying industries are recommended, and also the utilisation of the extensive forests for the production of valuable timber, guttapercha, indiarubber, &c. At present the forest lands bring in a revenue of 48,000*l.* in "acre money," nearly all of which is swallowed up in the cost of collection. Under competent management these forests could be made to contribute largely to the wealth of the Colony.

But there is evidently a stubborn determination on the part of a large proportion of the colonists in the West Indies to ridicule every proposal for the introduction of new industries, and notwithstanding the ruinous experience of recent years, they insist upon regarding sugar, and sugar only, as the sole means of salvation. Any person with an open mind who attends meetings in London at which the sugar planters or their representatives discuss West Indian affairs, cannot help being struck by the general desire to leave out of consideration questions relating to subsidiary industries. Still, in spite of this unwillingness to have other things to fall back upon, subsidiary industries are making some headway, and the out-and-out supporters of sugar growing cannot but admit that this is so. At the meeting of the Royal Colonial Institute on March 8, the lecturer stated that in the four essentially English islands of Barbados, Antigua, St. Kitts and Nevis, sugar is the sole possible staple; while in the five islands, Dominica, St. Lucia, St. Vincent, Grenada and Tobago, occupied by people differing from those in the other four in language and customs, the cultivation of sugar has given place to cacao, coffee, spices, and other products. Grenada, which sixty years ago contained 119 sugar estates, is now quite independent of sugar. Colonel Duncan has established on the island the largest and most valuable nutmeg plantation in any part of the New World. Are the misfortunes of the sugar-growing islands to be attributed to the "essentially English" character of their inhabitants?

Jamaica supplies us with a good illustration of the wisdom of selecting suitable marketable commodities for cultivation, in addition to the staple industry. As in other islands sugar was here once the one great object of cultivation, and in the year 1805 the exports were 150,352 hogsheads of sugar and over 5,000,000 gallons of rum. Even within recent years sugar, rum, and molasses formed the bulk of the trade, for in 1881-82 out of the total exports, valued at 1,178,594*l.*, the sugar products amounted to 910,027*l.*; but by 1895-96, when the total exports had increased to nearly 1,900,000*l.*, the sugar products had declined to little more than 360,000*l.* The serious depression in Jamaica dates back many years, and when it was hinted to the colonists that it would be well to introduce other cultural industries to assist in warding off the threatened crash, the idea was received with scorn and contempt. Thirty years ago Captain Bush, an American trader, began to encourage fruit growing, but for some years the venture made very slow progress, for by 1879 the fruit exports did not amount to 23,000*l.* It was realised, however, that the time had arrived to do something to save the island, and as there were no indications of an improved sugar trade, fruit had to come to the front, and by 1889 the exports had risen to 320,323*l.*, and by 1895–96 to 536,811*l.*, three-fifths of this trade being in bananas. From this it will be gathered that the fruit trade of the island is already far more valuable than that of sugar. One of the defects of the new industry is that there is not sufficient attention given to the manner in which the various fruits should be packed for the markets, an art in which our foreign competitors excel. In addition to sugar and fruit Jamaica has under cultivation coffee, cacao, allspice, ginger, fustic, &c., so that the entire failure of sugar would not now be anything like so disastrous as it would have been a quarter of a century ago.

All through this excellent and comprehensive report on a very difficult question, it is to be observed that the author does not propose anything with the object of hastening the end of the great sugar industry, but he recognises the necessity for supplementing, not supplanting, the staple trade by the introduction of a variety of cultural industries which would increase the wealth of the Colonies to an appreciable extent. In an appendix Dr. Morris propounds, at the request of the Chairman of the Commission, a scheme for the establishment of a Department of Economic Botany, and for agricultural instruction for developing the resources of the Leeward and Windward Islands and Tobago, and for affording assistance to the experimental cane cultivation to be carried on, in continuance of present efforts, in British Guiana, Barbados, and Antigua, at an estimated annual cost of 27,000*l.*, a scheme which, it is hoped, will be found to be accepted by the Government when Mr. Chamberlain brings the proposal for assistance before the House of Commons shortly.

H. H.

ON THE BREEDING HABITS OF THE GREY SEAL.

THE grey seal (*Halichœrus grypus*) is to be met with on many parts of the British coasts, from Orkney and Shetland, throughout the Hebrides, on the north and west coasts of Ireland, and occasionally on the south and east, on the coast of Wales, in the Wash, more rarely in the Solent, and as far south as Jersey (*Zoologist*, 1884, p. 337); hence greater opportunities for observing it, and learning something of its habits, have occurred than has been the case with the ringed, bearded, and hooded seals. Moreover, several observers have contributed information on its breeding habits and on the conditition of the young soon after birth. The following may be cited. So long ago as 1837, Mr. J. Wilson, writing on the habits of Scottish seals (*Mag. Zool. and Bot.*, i. p. 539), states that the young of the grey seal is "born above high-water mark in the end of September or beginning of October, and is at first covered with white hair, which is retained for many weeks, but shed before it takes to the water." His observations are confirmed by Edmondston, who, in his account of the seals of Shetland ("Zetland Isles," vol. ii. p. 294), remarks of the grey seal that the young are brought forth in September, October, or November. Nilsson and some other writers who have followed him have expressed the opinion that the breeding season of this species is in February; and Bell, in an attempt to explain this discrepancy ("Brit. Quad.," 2nd edition, p. 267), has suggested that the milder climate of Britain permits of pairing taking place much earlier than in Scandinavia. From the united testimony, however, of other observers, there can be no doubt that this is a mistake, and that the breeding season is in the autumn. Prof. Collett, of Christiania, who some years since contributed an excellent paper on the grey seal to the *Proceedings* of the Zoological Society (1881, pp. 380–87),

states that on the Fro Islands, off Trondhjem's Fiord, Norway, to which this species resorts in the breeding season, "the greater part give birth to their young in the last week of September, most usually on the 29th or 30th, or October 1—some a few days earlier and some later, but never after the middle of October." He adds: "The seals probably begin to breed at the age of four years, or at the earliest three years, and give birth to only one young one annually. The young seal at its birth is clothed with a wool-like covering, which falls off after the lapse of a fortnight. . . . The pups pass the first three weeks of their life on land until they have shed their woolly coat, often on exactly the same spot where they have been born, and pass their time exclusively in receiving nourishment from the mother and in sleeping."

As to the length of time the woolly coat is retained, some difference of opinion has been expressed. Prof. Collett, as above stated, believes that it is shed in about a fortnight, or between a fortnight and three weeks; and he derived his information from Mr. F. Borthen, the proprietor of the Fro Islands, who furnished him on several occasions with particulars concerning the seals during their stay at this group of islands. Mr. J. Wilson, already mentioned, states, somewhat vaguely, that the woolly coat is retained for many weeks. Dr. R. Ball, who furnished so much information to William Thompson, of Belfast, for his work on the natural history of Ireland, writing of the grey seal (*Trans. Roy. Irish Acad.*, vol. viii.) has observed more precisely that the very young females are generally "of a dull yellowish white, with rather long hair *which falls off in about six weeks* after birth, and gives place to a shorter and more shining coat of a warm dingy yellow, variously blotched with blackish grey, the whole gradually becoming more dull, and a general dark shade spreading over the back as the animal advances in age."

FIG. 1.—Young Grey Seal shortly after birth.

On December 24, 1881, one of the Trinity pilots, whilst off the Long Sand in the Lynn Roads, saw a large seal watching over the dead carcase of a recently born young one. On attempting to capture the old one she immediately showed fight, and had to be killed before she could be secured. This animal measured seven feet in length and five feet nine inches in girth behind the fore-flippers. It was identified as a grey seal by Mr. Thomas Southwell, of Norwich, who, in giving an account of the circumstance (*Zoologist*, 1882, p. 187), described the young one as being "of a beautiful silvery white, the muzzle sooty grey, a slight tinge of the same colour being visible on the back of the head, and for some distance along the spine."

The appearance presented by the young grey seal shortly after birth is well shown in the accompanying illustrations (Figs. 1 and 2), from photographs taken by Mr. Henry Evans, of Jura, during a visit to the Haskeir Rock in the Hebrides. Haskeir is a small rock about twelve miles west of North Uist. It is a great resort of grey seals, which breed there in October and November. It was formerly the custom with fishermen to visit this rock during the time it was frequented by the seals, and to kill them with clubs for the sake of their skins; but it is satisfactory to know, on the authority of Mr. Henry Elwes (*The Ibis*, 1869, p. 25), that this practice was put a stop to some years ago by Sir John Orde, the proprietor of the island.

From the foregoing remarks it will be evident that the suggestion (p. 346) that "the white coat is not improbably shed *in utero*," is not borne out by the testimony of the writers quoted. Nor is it only with the grey seal that this curious state of things exists. Dr. R. Brown, writing of the seals of Greenland (*Proc. Zool. Soc.*, 1868), states that the Greenland seal (or harp seal, as it is sometimes termed from the peculiar distribution of dark colour on the back) brings forth two young at a birth; that the pup "retains its white woolly coat for a fortnight or three weeks, and, *like the grey seal*, it refuses to enter the water until this is lost." Confirmation of this is to be inferred from the remark of Prof. Collett (*l.c.*), that the young grey seals during the first three weeks of their lives on land are "by no means so strictly confined to a dry place of rest, as is the case with the harp seal, which, so far as we know, never enters the water voluntarily *in its woolly coating*."

As to the common seal (*Phoca vitulina*), which pairs in September, and produces a single young one—sometimes two—in the month of June, it will not be irrelevant to refer here to the condition of the young at birth. A few years ago, towards the end of May, the late Mr. A. D. Bartlett purchased of a dealer in Liverpool four adult common seals, which were carefully transported to the Zoological Gardens. On June 9, one of them gave birth to a young one, whose appearance is thus described by Mr. Bartlett (*Zoologist*, 1881, p. 383): "It was covered with a rather thick coat of hair; its eyes very bright and wide open; it turned and rolled about, divesting itself of the outer covering of hair, which formed a complete mat upon which the young animal lay. For the first hour or two after its birth it was very active, and within three hours after its birth was swimming and diving about in the water like an adult animal. It uttered a low soft *bah*, or single call note, and looked about after its mother, and crawled towards her when she came out of the water. The mother would turn upon her side to let the young one suck. The latter was 32 inches long, and weighed 20 lbs. at its birth."

The difference between the common seal and the other species mentioned, as regards the condition of the young at birth and the shedding of the coat, is curious, and is perhaps to be accounted for in some measure by the different nature of their haunts at the time the young are born. The Greenland and grey seals bring forth their young upon rocky out-of-the-way islands, where they stand little chance of being molested, and consequently there is no need to get the young hurriedly to sea. The common seal, though breeding also on wild coasts, very often deposits the young on a sand-bank at no great distance from a fishing village, and subject sometimes to be submerged at high tides. On such banks the stay of the parent seals must be comparatively brief, for were the young not speedily able to take care of themselves, many would perish soon after birth. Thus it would seem that the greater activity of the young common seal is correlated with its conditions of life.

We have an analogous case in the difference to be found at birth in the rabbit and hare. The young rabbit born underground, where it is more or less removed from danger, is helpless and blind at birth; the young hare, deposited in a "form" on the surface, where it is more exposed to enemies, is born clothed with fur and with the eyes open. The rabbit stands in no need of early or rapid development; the young hare, on the contrary, must quickly leave the nursery and learn to shift for itself. So it may be with the seals.

J. E. HARTING.

FIG. 2.—An older pup, still retaining woolly coat.

SIR RICHARD QUAIN.

SIR RICHARD QUAIN, Bart., M.D., F.R.C.P., F.R.S., President of the General Medical Council, died on March 13, at the advanced age of eighty-one years. He had been ill for more than twelve months, and during the last half-year of his life was entirely confined to bed. His last appearance in public was when his paper on the "Cause of the First Sound of the Heart" was read before the Royal Society in June, on which occasion the President made a touching reference to the extraordinary courage which Quain displayed. His life had been one of ceaseless activity, good health, and overflowing spirits; and when overtaken by disease he appeared not to regard or understand rest, physician though he was. The paper just referred to was written in bed, and he left his bed to present and defend it. But no one was surprised at this who knew the story of the man's life.

Richard Quain was an Irishman, born at Mallow, Co. Cork, on October 30, 1816. As a child he was precocious. He was thoroughly grounded in English and the classics; distinguished himself at the public examinations, and at fifteen entered on an apprenticeship of five years as an apothecary. Even at this age he resolutely fought the cholera when it swept over Limerick. No doubt experience of this kind, and thus early, gave Quain courage and readiness in dealing with disease as a practitioner; but influences of more scientific bearing were to shape his career. The year 1837 finds him in London at University College, with a galaxy of teaching talent around him: Sharpey, Graham, Grant, Elliotson, Jones Quain the anatomist, and Richard Quain the surgeon and author of "The Arteries"—his cousins, from the same district—and as an instructor in practical surgery the great Liston, with whom Quain came to be on terms of intimate friendship. The clever young Irish lad, enjoying such advantages, immediately made his way to the front at College and University; and at the end of his curriculum as a student, obtained the coveted post of Resident Medical Officer at the Hospital.

It was shortly after this that Quain produced the brilliant research on the nature of fatty degeneration with which his name is associated for all time, and established his reputation as an original observer and thinker. Simple as the doctrine appears to us at the present day, fifty years ago it was a startling pronouncement by a young man fresh from his medical studies that fat may be, and often is, a product of the decomposition of muscular tissue, and that this change goes on in the living body. The ideas of life, nutrition, and death were greatly influenced by the doctrine. This, let us remember, was many years before Bauer and Voit, working with phosphorus in starving animals, furnished the proof experimentally and quantitatively; and Quain's claim was freely admitted by Virchow and Paget.

Although he was one of the founders of the Pathological Society, an early Secretary of it, and a frequent exhibitor at its meetings, Quain produced no other original work in this direction. His activities were being diverted into other channels. He quickly became popular as a practitioner; and having secured the valuable appointment of physician to the Brompton Hospital for Consumption, he was presently recognised as an authority on tuberculosis and diseases of the heart. Quain's personal qualities—the interest he displayed in his patients, his kindness, cheeriness, and cleverness in diagnosis and treatment—enabled him to turn to advantage his opportunities in practice; and whilst he was still comparatively young, he rose to the front rank of London consultants.

His heart was, for all this, even more closely set on the public work associated with Medicine. Medical education, medical research, medical relief at hospitals—these were the subjects at which he mainly worked, and with an energy and avidity which appeared to grow rather than wane as time passed and he attained in his old age the highest positions in the profession. A senator

of the University of London; chairman of the Brown Institution, with Burdon-Sanderson, Klein, Greenfield, Horsley, and their equally distinguished successors working as professors there; one of the most prominent Fellows of the College of Physicians, which was passing through a critical period of its history; and finally President of the General Council of Medical Education and Registration, of which he had been for thirty years a member—Quain had his hands full. Yet he never appeared to grudge his time to a friend in want of advice; and he was always keen and ready for the latest information in science. He had little time for ordinary literature. His nights were spent in writing—but in writing letters. It is true that he projected and edited the great Dictionary of Medicine with which his name is associated, and he wrote a few of the articles in it; but he produced—one might say "of course"—no book of his own. He had no patience for work of such a kind. Neither was he, nor could he have been, a teacher. He was much too quick in the workings of his mind to undertake instruction in laborious fashion.

Sir Richard Quain enjoyed the priceless privilege of the close personal friendship of many of the leading men of his time—Carlyle, Landseer, John Delane, Robert Lowe, and many others, particularly men belonging to the professions and the fine arts. He was a warm-hearted, generous friend, who never spared himself when he could be of service to others, particularly young workers at the medical sciences. His position was unique—won entirely by his ability and ceaseless energy—and cannot possibly be filled by another.

NOTES.

THE International Meteorological Conference which met in Paris in 1896 appointed a permanent Committee on terrestrial magnetism and atmospheric electricity, and submitted to the Committee a number of questions for report. In order that these questions may be well discussed, it has been decided to hold an international conference on terrestrial magnetism and atmospheric electricity in connection with the forthcoming meeting of the British Association at Bristol, which will begin on September 7. Letters of invitation are being sent out by the Committee; and all foreigners who propose to attend the conference may obtain tickets of membership of the British Association, free of charge, on application to the Assistant General Secretary of the Association. Among the subjects to be discussed are: the calculation of monthly means with and without taking disturbed days into account; the publication of the monthly means of the components X, Y, Z, and the differences ΔX, ΔY, ΔZ, of the monthly means from the preceding means; the establishment of temporary observatories, especially in tropical countries; and the relative advantages of long and short magnets. The decisions of the conference upon these questions will be reported direct to the International Meteorological Conference. But though the first business of the conference will be to report upon the questions submitted to them, papers and communications on other subjects connected with terrestrial magnetism and atmospheric electricity are also invited. It is desired that such papers be sent to the Committee some time before the opening of the British Association meeting.

A NUMBER of Fellows of the Royal Society have expressed a wish that a portrait of Lord Kelvin, who served as President from 1890 to 1895, should be placed in the apartments of the Royal Society, and a Committee is now being formed to carry out this object.

A BILL to amend the law with respect to vaccination was introduced in the House of Commons on Tuesday, and was read for the first time. The Bill provides that glycerinated calf lymph, the valuable properties of which were described in NATURE a few weeks ago (p. 391), shall be placed within the reach of all, and that no parents shall be required to submit their children for vaccination by means of anything but calf lymph. Vaccination will continue, as at present, to be obligatory; but vaccination by anything but calf lymph will cease to be compulsory. At present children must be vaccinated within three months after birth, but it is proposed to extend this period to twelve months.

IN the summer of 1897 a recommendation was made to the Government of India in support of the establishment of a physical laboratory in that country for advanced scientific teaching and research. The Government of India has now reported that the initial outlay on a physical laboratory of the kind described would be 60,000 tens of rupees, and that they are unable, in the present state of the finances, to entertain the scheme.

MAGDALEN COLLEGE, Oxford, announces that a Fellowship in Medical Science will be given by the College next October. From the terms of the announcement it appears that on this occasion the Fellowship will be bestowed merely for proficiency in the sciences related to medicine, as tested by examination; but that original work in these sciences will be fully recognised as a claim to distinction. The offering of this Fellowship affords new proof of the interest which Magdalen College—that has already done so much—still takes in the advancement of natural science.

WE regret to announce that Sir Henry Bessemer, F.R.S., the distinguished metallurgist and engineer, died on Tuesday evening.

THE eighth general meeting of the German Meteorological Society will be held at Frankfort-on-Main on April 14–16.

TOWARDS the end of the year 1896, at the request of a large number of distinguished men of science, philosophy and literature, Mr. Herbert Spencer agreed to have his portrait painted by Prof. Herkomer, for presentation to one of our national collections. The portrait is now finished, and will be sent to the next exhibition of the Royal Academy. In time it is intended to offer the picture to the Trustees of the National Portrait Gallery for hanging upon their walls.

WE learn from *Science* that the New York Zoological Society has secured the 100,000 dollars needed to enable it to take possession of the site provided by the city for a Zoological Garden. The total amount subscribed is 103,550 dollars, which included thirteen subscriptions of 5000 dollars each. According to the terms of the agreement between the Society and the city, as effected last year with the Commissioners of the Sinking Fund, the Society is under obligation to raise 250,000 dollars for buildings and collections, of which sum 100,000 dollars must be in the Society's treasury on or before the 24th of this month, and it was agreed that the Society could not take possession of the site until that amount had been provided.

AN Executive Committee of the Royal Zoological Society, Dublin, has made an appeal for subscriptions towards the erection of a "Haughton Memorial Building" in the gardens of the Society, in recognition of the important services rendered to the Society by the late Rev. Dr. Haughton, F.R.S., who for twenty-one years acted as its honorary secretary, and discharged the duties of president for five years. The form which the building will take has not yet been decided, but the Council of the Society propose that it should be one with a useful purpose. Sub-

scriptions in support of this scheme for perpetuating Dr. Haughton's memory may be sent to Prof. D. J. Cunningham, Hon. Secretary, Royal Zoological Society, Dublin.

THE death is announced of Prof. Kirk, Fellow of the Linnean Society. Prof. Kirk (says the *Times*), who was of Scotch extraction, spent the greater part of a long life in the Colony of New Zealand. In connection with the Department of Woods and Forests he rendered valuable official service. He was a distinguished botanist, and his "Forest Flora of New Zealand" is the standard work upon the forest growths native to the islands. Since the production of his principal work he has continued, from time to time, to publish interesting monographs upon New Zealand timbers. A very valuable report on the trees suitable for forest cultivation in the Colony was issued by him in 1886, at which time he held the position of Conservator of State Forests in New Zealand; and he is understood to have been engaged up to the moment of his death upon a great work devoted to the botany of Australasia. Prof. Kirk was an eminent member of the New Zealand Institute, and his loss will be much deplored in scientific circles, both in England and Australasia.

WE regret to announce that Dr. Ferdinand Hurter, who had been in weak health for some time past, died suddenly at his residence near Liverpool last Saturday. Dr. Hurter was a native of Schaffhausen, in Switzerland, where he was born in 1844. He early turned his attention to chemistry and its practical applications, and after serving an apprenticeship to a dyer in Winterhun, he pursued the same science at Zürich Polytechnic, whence he proceeded to Heidelberg, where he took his Doctor's degree in 1866. In the following year he came to reside in England, and was appointed consulting chemist to Messrs. Gaskell and Deacon at Widnes. On the formation of the United Alkali Company, he occupied the same position of principal chemist to that firm. In addition to much work connected with his own profession, he will also be remembered for his investigations of photometric subjects, and particularly for a very thorough inquiry, which he made some years back in cooperation with Mr. Driffield, into the action of light on the photographic film. Some of the scientific results to which he was led in the cause of the inquiry have been questioned; but his work had great effect in improving the artistic character of photographic reproduction, by his discussion of the effects of varying the exposure, and his insistence on the truthful rendering of tone. Dr. Hurter was prominently connected with the local scientific societies, having occupied the position of President of both the Chemical and Physical Societies of Liverpool.

THE first number of the new volume of the *Rendiconti del Reale Istituto Lombardo* contains the conditions and particulars of the prizes offered for competition in 1898 and 1899. Most of these prizes are open to all nations; but the essays must be written in Italian, French, or Latin, and forwarded under a motto to the Secretary of the Istituto Lombardo, Palazzo di Brera, Milan. The prizes of general interest are the following: (1) The Institute's prize of 1200 lire for the most complete catalogue of extraordinary meteorological events from the most ancient times down to 1800, excluding auroras and earthquakes, which have already been catalogued. Last date, May 1, 1899. (2) The Cagnola prize of 2500 lire and a gold medal (value 500 lire) for a critical review of the theory of electric dissociation, with new experiments. Last date, April 30, 1898. (3) The Brambilla prize of 4000 lire to whoever shall have introduced into Lombardy the most useful new machinery or industrial process. Names to be sent in by April 30, 1898. (4) The Secco-Comneno prize of 864 lire for the best description of the Italian phosphate beds, and proposals concerning their exploitation. Last date, April 30, 1902. All essays must be accompanied by an envelope bearing the motto outside, and the name and address of the competitor inside.

A VERY valuable volume on the sanitary circumstances and administration of 220 urban districts of England and Wales has been issued as a supplement to the report of the medical officer in the twenty-fourth annual report of the Local Government Board (1894–95). The volume summarises the results of the general sanitary survey of urban districts organised by the late Dr. F. W. Barry, and carried out under his supervision during the period 1893–95. It contains the results of one of the most important pieces of administrative work ever undertaken by the Medical Department of the Local Government Board, and as a trustworthy statement of the sanitary conditions of urban districts is invaluable. The districts are arranged in alphabetical order, and under each is described the conditions of dwellings and their surroundings, water supply, sewerage and drainage, methods of excrement and refuse disposal and removal, and conditions and nature of supervision over registered premises and trades. The general character and efficiency of the administration of the sanitary authority of each district is described under a separate heading. The present report, with the one previously published on port and riparial districts, contains the results of the sanitary survey of 396 districts, the topographical positions of which are shown upon a map. It is to be regretted that a survey of such distinct value to public health could not be made to embrace the whole of England and Wales.

A PRACTICAL demonstration of Dr. Carl Linde's method of producing extreme cold and liquefying air was given in the rooms of the Society of Arts on Monday and Tuesday; and the apparatus employed is described by Prof. J. A. Ewing in the current number of the Society's *Journal* (March 11). The method, it may be remembered, is a regenerative one; that is to say, the cold produced by the treatment of one portion of air is communicated to the portion which is next coming on to be treated, with the result that the air undergoes continuous cooling, which is only limited by the leakage of heat into the apparatus from outside. In Dr. Linde's apparatus the step-down or drop in temperature is produced by letting compressed air escape through a small orifice from a region of high pressure to one of low pressure. As air is not a perfect gas, in the thermodynamic sense, it is slightly cooled by the expansion it undergoes, even though it does no work. The fall of temperature is little more than a quarter of a degree for each atmosphere of difference in pressure between the two sides of the orifice; but Dr. Linde has shown that this small amount is enough to furnish the step-down necessary in a regenerative process. The gas, cooled slightly by passing through the orifice, gives up its cold to gas which is approaching the orifice. The passage through the orifice cools that gas further, and so on, with the result that a cumulative cooling proceeds. A temperature of $-200°$ C., or lower, may thus be obtained without much difficulty. The machine exhibited at the Society of Arts circulated about 15 cubic metres per hour in a circuit in which the fall of pressure was from 200 atmospheres to 16 atmospheres. About 0·9 litres of liquid air was produced per hour, with a continuous expenditure of three horse-power. Dr. Linde is constructing a machine of 120 horse-power for the Rhenania Chemical Works at Aix-la-Chapelle, which is to be applied to the improvement of the Deacon process of chlorine manufacture. This machine is expected to produce 50 litres of liquid air per hour.

ATTENTION has recently been called, in two communications, to sources of error likely to arise in temperature determinations by means of thermometer readings. One of these has reference to the possibility of minute errors arising from expansion of the

attached scale, when that form of thermometer is used. Opportunity for the determination of the amount of this error has offered itself at the Physikalisch-Technischen Reichsanstalt. Two pairs of thermometers, each pair being made of similar glass, and one pair divided on the stem, and the other on the scale, have been rigorously tested. The result is that the third place of decimals is not trustworthy if precautions have not been taken to remove the effects of the expansion of the scale. The other has reference to the accuracy of thermometric readings when the instrument is exposed in a medium whose temperature is rapidly changing. Dr. Hergesell, of Strassburg, in his investigation of the temperature of the air at considerable elevations, as derived from heat-registering apparatus carried in balloons, has been led to the conclusion that in order to ascertain the temperature of the air, it is necessary to take into account two corrections which can have a very important effect upon the result. One of these corrections, depending upon the velocity with which the registering apparatus is carried through the air, he has endeavoured to determine by actual experiment made in the Seewarte at Hamburg. The thermograph was mounted upon the whirling apparatus used for testing the anemometers, and driven with various degrees of velocity varying from zero to seven metres per second. The thermograph was warmed to about 30° C., and precautions taken to ensure uniformity in the distribution of the temperature. The arms were then rotated, and when the temperature of the thermograph had fallen to that of the testing-room, the resulting curves show the rate of cooling under the varying velocities.

The second correction, which Dr. Hergesell calls the "inertia coefficient" in the paper referred to above, depending upon the variation of density of the surrounding medium, cannot be determined experimentally with the same ease. The author prefers to use the temperature recorded on the thermogram at equal, but considerable, altitudes on the ascending and descending journey. At an altitude above 4000 m. it may be assumed that the daily variation of temperature ceases, and therefore the difference of time at which the two readings are taken is immaterial. Dr. Hergesell makes use of the record of the balloon journey made February 18, 1897, from Paris. The temperature records in ascending and descending are arranged as functions of the atmospheric pressure, and show on the whole a tendency to regular deviation from each other. The greatest separation occurs at a pressure of 400 to 500 mm., while at 200 mm. the curves tend to become parallel. Dr. Hergesell assigns to the "inertia coefficient," which at the usual atmospheric pressure is unity, a value four times as great in a density corresponding to a pressure of 500 mm. In thermographs as at present arranged, the difference arising from these two sources of error, between the reading indicated and the true temperature, may amount to as much as 12°.

The eleventh annual report of the Liverpool Marine Biology Committee has lately appeared, containing an account of the work done at the biological station at Port Erin during 1897. The year has been comparatively uneventful, but among the recent developments of the work of the station we notice a scheme for the simultaneous observation and record of surface organisms at different stations in the Irish Sea. Attention may be called to an obvious error on p. 13, in regard to the specific gravity of the sea-water in the tanks.

Mr. H. L. Clark has described the development of a viviparous Synapta which is abundant among algæ attached to mangrove roots in the West Indies. His observations induce him to support Ludwig's views concerning the degraded rank of the Synaptidæ in opposition to Semon's interpretations. In regard to the ancestry of Echinoderms as a whole, he again opposes Semon, and finds himself in close agreement with Bury; but, as the development of *Synapta vivipara* is direct and without metamorphosis, it is obvious that his criticisms of Semon's work cannot be regarded as final.

A recent number of the *Journal of the Society of Arts* contains an excellent review of the late outbreaks of plague in Bombay, by Mr. H. M. Birdwood. An account is given of the organised endeavours of the Government to combat the scourge, and some real idea of its extent may be gathered from the statement that up to the end of last year 56,000 deaths from plague had been reported for the whole Presidency, but that the actual number was probably not less than 70,000. Opinion appears to be unanimous that the utter disregard of the poorer natives for the commonest sanitary laws, and the horrible houses and "chawls" in which they principally live, are largely responsible factors for the firm hold which the disease has taken in the city of Bombay. The eminent authority, Dr. Cleghorn, who was deputed by the Government of India to study the position of affairs in Bombay, has vividly described the housing of the native population there. He tells us that the so-called chawls are mostly great buildings five to seven stories high on the flat principle, each flat containing a long corridor with rooms about 8 feet by 12 feet in size opening into it on either side; these rooms were usually inhabited by six to eight or even more persons, and the state of filth in these corridors, which are practically the receptacle for refuse from all the rooms, is indescribable. Each chawl contains from 500 to 1000 persons, and 70 per cent. of the native population are housed in this way. Dr. Cleghorn further goes on to say that such places were only to be seen in Bombay, and the marvel is not that so much plague abounded, but that it had not carried away at least half of the population. To cope with this terrible legacy of past generations of responsible authorities is no light task, but the Government are devoting their most earnest attention to carrying out a large and important scheme for the sanitary renovation of Bombay. It is discouraging in the highest degree to find that, despite all the heroic efforts which have been made to cope with the scourge, it has appeared with renewed strength, and an epidemic has been established for a second season in Bombay.

We have received from the Director, Mr. N. A. F. Moos, the Report of the Bombay Magnetic and Meteorological Observatory for the year 1896. In addition to the general tables giving the readings of the self-recording magnetic and meteorological instruments, the report contains an account of the absolute measurements made during the year in order to standardise the self-recording instruments. In an appendix a short account is given of the disturbances produced on some of the self-recording instruments by the earthquake on June 12, 1897. Enlarged copies of the photographic trace of the disturbed instruments are included, which add considerably to the interest of the report. From the character of the disturbances the Director concludes that the disturbance of the magnetic instruments was not entirely of a mechanical nature, but that the earthquake did really produce a disturbance of the magnetic elements. The appendix also contains a discussion of fifty years' observations of declination made with one of Grubb's declinometers at the observatory.

The United States Weather Bureau has published a discussion of the Floods of the Mississippi River, prepared by Mr. Park Morrill, the Forecast Official in charge of River and Flood Service. The paper refers to the chief characteristics of that river and of the basin that is drained by it, and contains valuable and trustworthy information as to the rainfall (which is the principal cause of the floods) and drainage under normal conditions, by means of a large number of tables and charts. These show that the difference in the amount of summer and winter rainfall is very great, the former being five or six times the latter

in some districts. The floods occurring during the last twenty-six years, during which time trustworthy gauge readings are available, have been specially investigated; this period embraces six notable flood-years. The downfall of water in each of these has been computed, and the results are given in tabular form; the most destructive floods occurred in 1882, 1890 and 1897. In the latter year the river rose higher than was ever known below Cairo, but the duration of high water was exceeded in 1882 and 1884. One of the duties of the Weather Bureau is to issue warnings of impending floods, and it is satisfactory to note that ample notice is usually given. Indeed, so completely was the public warned on this last occasion that the Bureau was criticised for needlessly alarming the people in the threatened districts, but subsequent events fully justified its action.

FOLLOWING a recent example, the Royal Geographical Society has issued the first number of a "Year-Book and Record," designed to afford information respecting the constitution and working of the Society, and its annual progress. It seems somewhat strange that so useful a publication should not long ago have come into vogue; but we gladly welcome the new-comer as tending very considerably to enhance an interest in geography. Following the charter and bye-laws, an interesting account is given of the library and its contents, as well as of the map-room. Her Majesty's Government give 500*l.* per annum to the latter on condition that the public have access to the maps and charts. The illustrations are a pleasing feature, and give point and variety to the subject-matter. They comprise a view of the Society's house in Burlington Gardens, and selected parts of the interior, together with sundry plans; while very satisfactory reproductions are given of the two Royal medals and of the special medals which have been awarded from time to time for eminent services to geography. Some indication of size might well have been given here; if we mistake not, the gold Stanley medal was of quite heroic proportions—far larger than the illustration would make it appear. The list of recipients, beginning with Richard Lander, who received a Royal medal in 1832 for his discovery of the course of the River Niger, and the accompanying statement of the grounds of each award, is of distinct interest in this publication, connecting as it does the geographical progress of the past with the present. A long catalogue of pictures and busts is given. In another issue it would be useful, for reference, to supply painters' and sculptors' names.

HERR F. E. SUESS communicates to the *Verhandlungen* of the Austrian Geological Department some details of the earthquake at Graslitz between October 25 and November 7 of last year. It appears that the disturbance belonged to the group called "Vogtland-Erzgebirge" by Credner, and it is remarkable that at the end of the Graslitz earthquake the centre of disturbance seems to have moved to another locality as yet undetermined.

WE have received a paper by Prof. Dr. Eduard Richter, of Graz, containing an account of soundings and temperature observations made by the author in the lakes of Carinthia, Carniola, and Southern Tirol. The data discussed form the basis of the second part of the Atlas of the Austrian Lakes, produced under the joint editorship of the author and Prof. Penck, and published in the Vienna *Geographische Abhandlungen.*

THE *National Geographic Magazine* for January contains an article by Mr. Robert Stein, of the U.S. Geological Survey, on "Three Weeks in Hubbard Bay, West Greenland": the author, anxious to gain experience in Arctic work, was landed by Peary in his last expedition. Another paper, by Mr. W. J. McGee, deals with the "Modern Mississippi Problem," defined as being "not that of navigation, not even that of normal regimen as a great river, but that of the floods to which the stream is subject."

"THE Mechanics of Soil Moisture" forms the subject of a paper by Mr. Lyman J. Briggs, published by the United States Department of Agriculture. In it the author explains in simple terms such of the physical properties of liquids, including surface tension and viscosity, as are necessary to explain the retention and motion of water in the soil. To scientific students of agriculture, such an insight into the elementary laws of capillary phenomena will be useful in enabling them to explain the why and wherefore of the differences between heavy and light soils.

IN a *brochure* of six pages, on "Æther, its Nature and Place in the Universe," by Dr. Hugh Woods, published by the *Medical Magazine* Publishing Company, the author, after propounding his views on the existence of the ether and the why and wherefore of certain laws of nature, concludes by remarking: "The theory opens up far too wide a field for one man to traverse, however cursorily, especially when he can devote only a few leisure minutes to the difficult and laborious task." With this opinion we are certain that all who have read the paper will unanimously concur.

THE "Electrical Trades' Directory and Handbook," noticed in last week's NATURE, contains 1174 + clix pages in all, including the pages of advertisements. The extensive character of the electrical and allied industries may be gauged by the great size of the new volume of this Directory.

AN English edition of the two volumes of "Audubon and his Journals," the American edition of which was reviewed in NATURE of February 24 (pp. 386–7), has just been published by Mr. John C. Nimmo. Every field club and naturalists' society should add the volumes to their libraries, for they are full of interesting notes on outdoor natural history, and on the character and methods of a naturalist whose name is familiar to all observers of nature.

A SECOND edition of Prof. Heinrich Weber's systematic treatise on algebra, the "Lehrbuch der Algebra" (Brunswick: Vieweg und Sohn) is in course of publication, and the first volume of the new edition has just appeared. The scope and value of this masterly work has already been indicated in NATURE (vol. lv. pp. 25 and 481, November 12, and March 25, 1896). In the new edition the plan and method of the original work has been retained. About fifty pages of new matter have been added; corrections have been made where necessary, and paragraphs which appeared slightly obscure have been elucidated, while the section on the theory of elimination has been considerably enlarged.

AN ingenious actinograph, devised by Dr. Hurter and Mr. V. C. Driffield, has been sent to us by Messrs. Marion and Co. By means of a small double slide-rule, and a sliding set of curves movable at right angles to the motions of the rules, the variables concerned in photographic exposure are shown in their varying relations to one another. To find the time of exposure, the scales corresponding to the light, the lens, and the speed of the plate are set in their proper positions, and then the correct exposure can be read off. For photography under various conditions, such as views, portraiture, interiors, and copying, a table of factors are given. By using the actinograph intelligently a photographer may be confident of obtaining a good negative.

APPARATUS for simple experiments in physics, such as are described in manuals and text-books used in elementary physical laboratories, now take a prominent place in the catalogues o

scientific instrument makers. A catalogue just received from Messrs. W. and J. George, Ltd., the successors to the late firm of Becker and Co., contains illustrations and prices of apparatus described in the volumes on practical physics by Schuster and Lee, Stewart and Gee, Watson, and Glazebrook. Similar catalogues have lately been published by Messrs. Griffin and Sons and Messrs. Philip Harris and Co. It is satisfactory to know that scientific instrument makers are beginning to understand the necessity of producing simple apparatus at a low price, now that students of physical science are expected to gain their knowledge by individual experience, even in the most elementary stages of the subject. What some of them have yet to learn, however, is that the apparatus is not intended as toys, but as a means of obtaining quantitative results; and unless this end is attainable, the instruments are of little value.

THE annual report for 1896-97 of the Director of the Field Columbian Museum, Chicago, is of interest to curators of museums, and records much progress. It is profusely illustrated by photographs of the rooms, and case-objects. In the division of economic botany, what is called a monographic installation of material exemplifying the North American forest trees is being pursued. The elements of the series comprise a branch, flowers, and fruit from the same tree, a photograph of the tree in summer, and in winter, a seven-foot length of trunk, and transverse section, a two-foot map, coloured to show the distribution of the species, and ornamental cabinet specimens. In the department of zoology the cases have been painted black inside. The report on the expedition and field work is of unusual interest. An account is given of the party which entered Somaliland under Mr. Elliot. He regards the collections made as very valuable, and probably the most important, especially as regards quadrupeds, ever brought out of any country by an expedition. Casts of heads and parts of bodies showing the muscles of the large animals were made, which will prove of the utmost service during mounting. Besides these, over 300 photographic negatives are in hand illustrating the scenery, the people, and also the animals, both living and dead. The last-named will be used in conjunction with the casts. It may be noted that the museum mostly does its own printing.

THE additions to the Zoological Society's Gardens during the past week include two Prairie Marmots (*Cynomys ludovicianus*) from North America, presented by Mr. J. Maurice Glyn; a Spotted Ichneumon (*Herpestes auropunctatus*) from Nepal, presented by the Rev. Sidney Vatcher; a Great Eagle Owl (*Bubo maximus*), European, presented by Captain Betram Goff; two Indian Chevrotaints (*Tragulus meminna*, ♂ ♂) from India, a Mantell's Apteryx (*Apteryx mantelli*), an Owen's Apteryx (*Apteryx oweni*) from New Zealand, two Cardinal Grosbeaks (*Cardinalis virginianus*) from North America, eight Undulated Grass Parrakeets (*Melopsittacus undulatus*) from Australia, a Brown Gannet (*Sula leucogastra*) from South America, a Black Lark (*Melanocorypha yeltoniensis*, ♂) from Siberia, four Chinese Quails (*Coturnix chinensis*) from China, a Black Woodpecker (*Picus martius*), a Solitary Thrush (*Monticola cyanus*), European, purchased; a Leopard (*Felis pardus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

CONSTANT OF ABERRATION.—Prof. C. L. Doolittle, from observations made at the Flower Observatory of the University of Pennsylvania, contributes a paper on this subject to the *Astr. Jour.* 428. He states "that in view of the present interest in the values of the astronomical constants, the investigation is published earlier than was intended. The result is preliminary in the sense that it is derived from a limited amount of material, which will ultimately be combined with other data." Küstner's method was employed, and he obtains a result of 20″·572 ± 0″·009, which is even larger than his recent deduction of 20″·55 from his South Bethlehem observation.

Since the adoption, then, of 20″·47 at the Paris Conference, the four most recent deductions all give higher values, viz. 20″·55 (Doolittle), 20″·533 (Fergola), 20″·57 (Finlay), and 20·572 (Doolittle).

WINNECKE'S COMET (*a* 1898).—This comet will make its perihelion passage in a few days—March 20. In *Astr. Nach.*, No. 3480, Dr. Hillebrand publishes a continuation of the ephemeris, which shows that the comet is on the borders of Aquarius and Capricornus, having passed between α and β Capricorni some few days ago. It is moving slowly in an easterly direction, but is badly placed for observation; so that it is unlikely to be seen again in ordinary telescopes until its next return in 1904.

NEW VARIABLE STARS.—We learn from the *Astronomical Journal*, No. 428, that the variability of the star S.D.M. –20°·2007, announced by Mr. Perry in No. 398 of that *Journal*, has been confirmed by Mr. Parkhurst, and in consequence the definite notation 2689 Z Puppis has been assigned to it.

The star in Gemini, announced as variable by Mr. Anderson in *Astr. Nach.* 3463, has also been confirmed by Mr. Parkhurst, and accordingly it has been called 2404 X Geminorum.

ASTRONOMICAL SERIALS.—The *Berliner Astronomisches Jahrbuch* for 1900 has recently been issued, under the editorship, as before, of Prof. Bauschinger, Director of the Rechen-Institut at Berlin. It contains particulars of the solar eclipse which will occur on May 28 of that year, and will be visible as total in the States of Georgia and South Carolina. Leaving North America the shadow band crosses the Atlantic, and strikes Europe on the coast of Portugal near Oporto, passing over Spain and Algeria.

The *Jahrbuch* contains the elements of all the small planets up to No. 425, which was discovered December 28, 1896, by M. Charlois; also opposition elements of a selected number.

The data and arrangement are the same generally as in previous years, but some important changes are contemplated in the planetary table for future years.

In the *Bulletin de la Société Astronomique* for this month there are several reproductions of the partial eclipse of the moon which took place on January 7. The photographs illustrating the various phases were taken by MM. Quénisset and Touchet; one at maximum is from a negative taken by M. Rudaux.

In the same *Journal* there is a summary of Prof. Schiaparelli's fifth "Memoir on Mars," containing his observations made during the opposition in 1886. The author has not given a general chart of the planet for this year, but his observations of 1886 happily complete our aerographical knowledge, by a rigorous examination of the north-polar region. A fine chart illustrating this region accompanies the paper, together with various aspects of the planet on different dates.

Five instantaneous photographs of Jupiter are also reproduced from photographs taken by Prof. Barnard at the Lick Observatory with the 36-inch telescope.

THE SPITSBERGEN GLACIERS.

ON Monday last Sir W. Martin Conway delivered a lecture before the Royal Geographical Society, in which he described the principal results of his second expedition to Spitsbergen, undertaken in conjunction with Mr. E. J. Garwood, in July and August 1897. It will be remembered that in the previous summer Sir Martin Conway, with several companions, for the first time explored, with any thoroughness, certain parts of the interior of the main island of Spitsbergen, throwing much new light on the physical features of the island and their mode of origin. In that year the principal attention was directed to the country south of Ice Fiord, between it and Bell Sound, the result being to show that this region was by no means the ice-clad country it had previously been considered. The principal object of last year's expedition was to examine a new section of the interior, north of Ice Fiord, which was still believed by some to be covered with an ice-sheet similar to that found in Greenland. Two districts in particular were chosen as the field of operations, the one (named by the lecturer Garwood Land) occupying the area between the extremities of Wijde Bay and Ice Fiord in the west and the sea in the east; the other lying west of the line joining the heads

of Wijde Bay and Ice Fiord. For this second region Sir Martin Conway has revived the old English whalers' name for Spitsbergen as a whole—King James Land.

Although the routes naturally did not extend over a very large area, considering the comparatively short time available for the exploration, Sir Martin Conway had a most interesting story to tell of a fight against difficulties, such as are presented to the explorer by few, even of the most remote regions of the world. His graphic descriptions, reinforced by the unusually fine representations of scenery supplied by Mr. Garwood's photographs, brought home to his hearers the chief characteristics of the country in a way which could only be surpassed by an actual visit to the scenes described. He also gave the meeting an instructive study of the problems in physical geography which he thinks may be solved by his examination of the country. Garwood Land was first visited, a landing being effected at the foot of the Nordenskiöld Glacier, near the head of Klaas Billen Bay, one of the principal branches of Ice Fiord. The route led a little east of north, progress being difficult at first on account of the labyrinth of crevasses which intersect the glacier, and afterwards by reason of dense fog, and violent snowstorms. Particularly forcible was the lecturer's description of the white curtain of fog in which he and his companions were enwrapped for days together, and which in time caused a dazed feeling as if they had taken entire leave of the solid earth, and were floating in some unsubstantial nebula. The steep snow slopes entailed arduous labour in dragging the sledges, but after the fourth camp had been left some high snow domes were reached, from the summits of which views down broad valleys to the east and north were obtained, displaying a succession of plateau-fronts or bluffs of rock with *névé* both below and above them. The scenery, as seen by the evening light, was described as superb, the panorama being a glorious mass of colour. Returning to the coast, the travellers next proceeded to King's Bay on the west coast of the island in 79° N., and thence penetrated inland into an interesting region of peaks and glaciers, several of the former being climbed. The principal mountain group is known as the Crowns, and lies between the two main branches of the King's Glacier. The peaks of this region present striking characteristics, well shown by the photographs displayed on the screen. The weather during this expedition was the most perfect imaginable. A week at Horn Sound, near the south end of the island, during which Mount Hedgehog, one of the highest peaks of the Hornsunds Tinder, was climbed, concluded the expedition. Dense fog was again encountered here, and the difficulties of the ascent were altogether out of proportion to the comparatively small elevation above sea-level, the extent of the actual climb (in the Alpinist's sense of the word) far exceeding that in the case of many of the more difficult summits of the Alps.

The principal geographical result of his second visit to Spitsbergen is, Sir Martin Conway considers, the discovery that neither of the districts visited, nor, in fact, any large part of the islands except New Friesland and North-East Land, is covered by an ice-sheet. As long as a flowing body of ice is contained within definite mountain ranges, it is a *glacier*, and the districts visited were both merely glacial and mountain areas. The importance of distinguishing clearly between the two types of ice-bearing country was strongly insisted upon by the lecturer, on account of the different natural processes to be seen at work in the two. The insignificance of the excavating action of ice was stated, perhaps, somewhat too uncompromisingly; but at any rate, as was shown by Sir Martin Conway, the forces acting on the land-surface beneath an ice-sheet are mainly conservative; while in a glacial region, the rock-faces which rise above the general surface are exposed to rapid denudation, and great developments of surface-form are going forward. The "eating-back" processs, recognised as a powerful agent of denudation in the case of rivers, was held to be equally effective in that of glaciers, although, of course, the result is due to aerial denudation, not to glacial erosion. The work of the glacier is to carry away the débris, the accumulation of which would otherwise arrest the process of denudation. Examples were given by the lecturer from the Bernese Oberland and the Karakoram Himalayas, in which the present surface features are, in his opinion, due to this eating-back process, which has entirely modified the original longitudinal drainage of the mountain masses. The great bluffs of the Oberland—the Eiger, Mettenberg, and Wetterhorn—show a striking resemblance to those of Spitsbergen's Sassendal.

At the close of the lecture Mr. E. J. Garwood gave some interesting details regarding the geological features of the country traversed, adding besides some graphic descriptions of the marvellous effects of colour, which give to the scenery of Spitsbergen such a unique character. Among the points touched upon was the presence in Spitzbergen, contrary to the formerly accepted idea, of a snow-line some 1200-1500 feet above sea level. The contrast in the surface features above and below this line is most marked, the lower slopes showing as well-marked a denudation curve, with gullies due to flowing water, as may be seen in our own islands, while the upper regions show the abrupt rock-faces due to frost denudation. In the case of the Crowns this has acted along the vertical joint-planes of the carboniferous limestone rocks which form, as it were, a golden crown above the purple Devonian shales of which the more gradual, lower slopes are composed. Mr. Garwood also gave an account of the en-glacial streams, which often flow in a direction at right angles to that of the main valley, and which, on the retreat of the glacier might leave behind deposits similar to the kames and eskers which have so puzzled geologists in other countries. The remarkable ice-tunnels observed may be due, he thinks, to the arching up of ice-bridges over crevasses, when these are closed up by the movement of the glacier.

A short discussion followed, devoted chiefly to the theory propounded by the lecturer with regard to the action of glaciers in modifying the surface features of a country.

Prof. Bonney, while allowing that the action supposed undoubtedly makes itself felt in certain cases, doubted the admissibility of a comparison between a plateau region like Spitsbergen and a region of narrow ridges like the Alps. The V-shaped Alpine valleys as a rule follow the lines of dip and strike, just as they do in unglaciated regions, while everywhere evidences of pre-glacial structure are to be found. From what we know of the climate of the Alps before the glacial epoch, we may conclude that in more remote times practically no glaciers existed. The characteristics noted by Sir M. Conway are, he considered, rather to be accounted for by the two distinct disturbances which have operated in the Bernese Oberland. The phenomenon adduced is, therefore, probably not more than a secondary cause in the moulding of the features of a country.

Mr. J. E. Marr doubted whether the side-glacier, shown in Sir M. Conway's diagram as hanging like a tear-drop on the mountain side, could be properly described as cutting back through the mountain wall behind it. It was important to keep clearly in view that the wearing-back process, even in the case of glaciers, was really due to the action of the weather at their head.

Sir Erasmus Ommanney expressed his high appreciation of the work done by Sir M. Conway and Mr. Garwood, and of the manner in which the results had been presented.

Dr. J. W. Gregory agreed in the main with Prof. Bonney, holding that though the phenomenon alluded to was no doubt a true cause, it was very uncertain whether it were a primary one.

Sir Henry Howorth considered that Sir M. Conway's theory had at least this in its favour—that it was consistent both with the laws of physics and of ice. He called attention to the change of climate which Spitsbergen has undergone in recent geological times, and to the fact of its belonging to the area of land rising in level around the North Pole.

THE LAKE SUPERIOR IRON ORE REGION.

AT the present time the conditions and prospects of American competition in the iron trade call for very serious consideration. The aggregate value of iron and steel exported from the United States to Great Britain and the continent is now considerable, the official figures for the first nine months of 1897 giving a value of 45,693,000 dollars, as compared with 34,549,000 dollars for the corresponding period of 1896. With this increase in the exports, there was a decrease in the imports from 16,361,000 dollars in the first nine months of 1896 to 10,032,000 dollars in the corresponding period of 1897. The rapidly increasing intensity of American competition is thus apparent. The exportation of iron and steel is not a result merely of depressed conditions in the United States, but of lower cost of production, brought about by enforced economy in labour, by the great discoveries of cheaply worked ore, and by the increased

efficiency of the mining and metallurgical plant in use. Undoubtedly the greatest advantage possessed by the United States is that in the Lake Superior region they have the most extensive supplies of cheap and rich iron ores known to exist. It is to the sudden development and unparalleled richness of these deposits that the United States chiefly owe their cheap pig iron. It is, therefore, a matter of extreme satisfaction that an authoritative description of these deposits has been prepared by Mr. Horace V. Winchell for English readers in the form of an admirably illustrated monograph,[1] covering seventy pages of the *Transactions* of the Federated Institution of Mining Engineers, and dealing with the history, geography, geology, and mining industry of the iron-ore region. Only forty years have elapsed since the first regular mining of iron ore was begun in the district, and during that time up to January 1, 1897, the total output was as follows :—

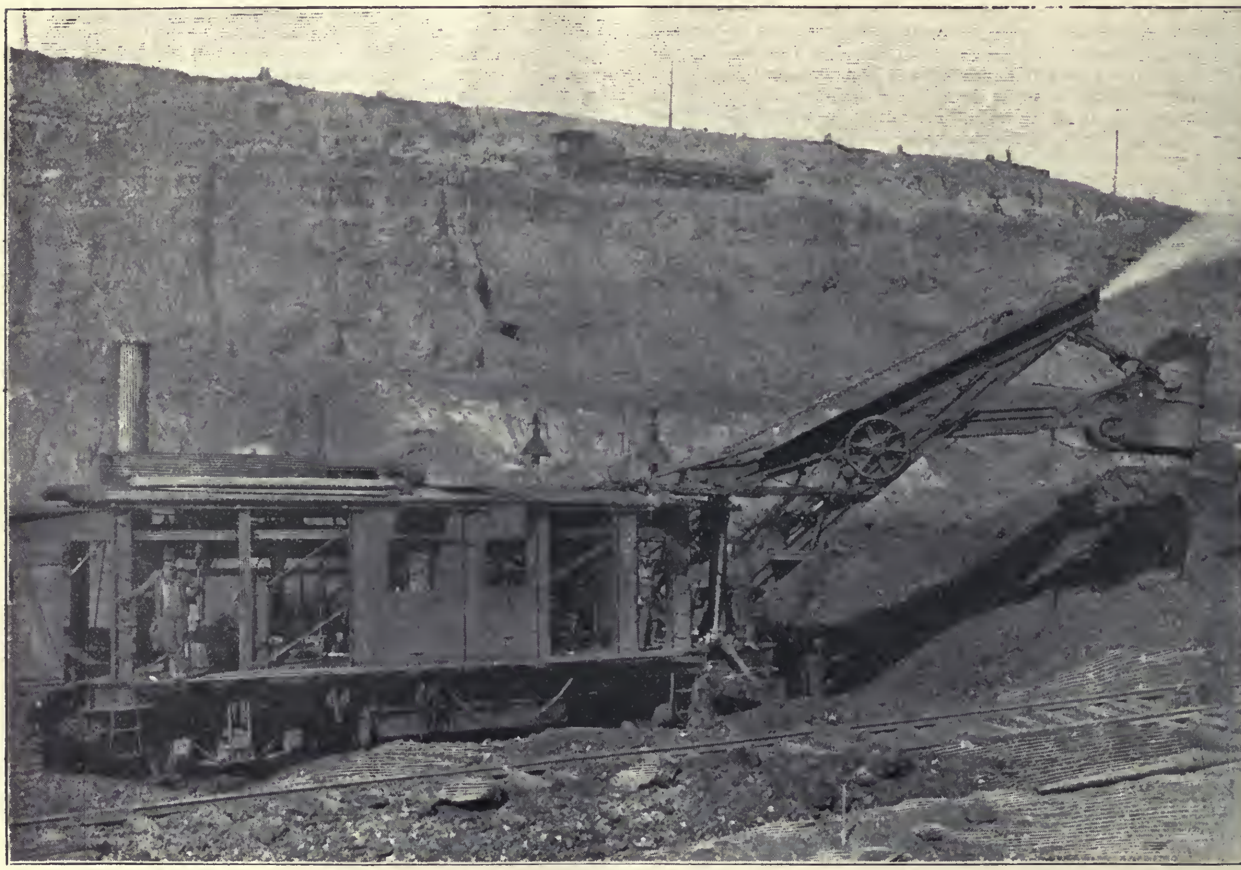
Range.		First year.		Tons.
Marquette	...	1856	...	46,538,187
Menominee	...	1880	...	22,994,428
Gogebic	...	1884	...	20,788,787
Vermilion	...	1884	...	9,220,235
Mesabi	...	1892	...	8,074,583
Miscellaneous	...	...	...	2,320
Total production to date			...	107,618,540

According to the official statistics, the production in 1896 was as follows :—

Range.		Tons.		Per cent. of total.
Mesabi	...	3,082,973	..	29·18
Marquette	...	2,418,846	...	22·89
Gogebic	...	2,100,398	...	19·88
Menominee	...	1,763,235	...	16·69
Vermilion	...	1,200,907	...	11·36
Total	...	10,566,359	...	100·00

The iron-ore belts or ranges are situated chiefly in the States of Michigan and Minnesota. The beds occur in rocks of pre-Silurian, and probably of pre-Cambrian age, the determination of the geological age resting wholly on structural evidence. As to the genesis of the ores, there has been much speculation. The principal theories are (1) the obsolete one that the ores are of eruptive origin ; (2) that they are mechanical sediments ; and (3) that they are of chemical origin. Under the third head, the chemical action may have been that of original precipitation, or that of replacement or segregation of chemical or clastic materials by the substitution of iron oxides. Mr. Winchell inclines to the theory of oceanic precipitation advanced by him in 1889. He considers, however, that there is no reason to suppose that all the iron-ore deposits were formed in the same way.

From an engineering point of view, the Lake Superior region is remarkable for the manner in which labour-saving appliances are adopted for extracting the iron ore and for loading it into railway waggons and vessels. The result being that at the present time the mining cost is much below that at any previous period. Thus in 1890, when the Iron and Steel Institute visited the Lake Superior iron mines, the average cost of mining was 5*s*. per ton. At the present time it is 2*s*. 6*d*. per ton. In most cases the methods of mining adopted are those usual in under-



Oliver Iron Mine, showing a face of ore 50 feet high.

[1] "The Lake Superior Iron-ore Region." By Horace V. Winchell. (Excerpt from the *Transactions* of the Federated Institution of Mining Engineers, 1897.)

ground mines. On the Mesabi range, however, some of the largest mines are worked as open quarries, the ore being obtained by steam shovels at a cost of $7\frac{1}{2}d.$ per ton. The accompanying illustration shows the steam-shovel method of mining at the Oliver Mine on the Mesabi range. The face of iron ore is 50 feet high, and the 90-ton steam-shovel with a $2\frac{1}{4}$ cubic yard digger shown, is capable of loading 500 tons of ore per hour. It is difficult to over-estimate the value to the United States of the discovery of ore in the Mesabi Range. A producer for only four seasons, this district has in sight to-day nearly 400,000,000 tons of better ore than the average used in the United States, and perhaps 200,000 tons of ore containing 60 per cent. of iron, 0·06 per cent. of phosphorus, and 10 per cent of moisture. Indeed, Mr. Winchell thinks that it is not unreasonable to assert that the range will produce 500,000,000 tons of ore before it is abandoned.

At the present time the cost of a ton of Mesabi ore laid down at a Lake Erie dock is made up of the following items:—

	s.	d.		s.	d.
Royalty	0	0	to	1	$5\frac{1}{2}$
Mining cost	0	$7\frac{1}{2}$	to	3	$1\frac{1}{2}$
Railway freight	1	4	to	4	2
Lake freight	2	6	to	3	4
Insurance, commission, and loss ...	0	$2\frac{1}{2}$	to	0	10
Totals	4	8		12	11

There is probably no mine which has all the minimum costs, and it is evident that prices may go still lower without shutting up enough mines to produce a scarcity of ore. Mr. Winchell appends to his valuable paper a carefully compiled bibliography, tables of analyses, and statistics of shipments for the past forty-one years.

BENNETT H. BROUGH.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following is the speech delivered on March 10 by the Public Orator, Dr. Sandys, in presenting, for the honorary degree of Doctor in Science, Prof. Wilhelm Pfeffer of Leipzig, Croonian Lecturer of the Royal Society, 1898:—

Veris adventu iam propinquo, dum terra gaudet, dum caelum avet nitescere, et arbores frondescere, nihil auspicatius ducimus quam veris quasi praenuntium quendam trans maria advectum verbis bene ominatis salutare. Salutamus praeceptorem insignem, qui rerum naturae pulcherrimam nactus provinciam, discipulos ex omni orbis terrarum parte affluentes docet, qua lege lilia crocique calyces suos explicent; quo admonitu flores, alii solis calore, alii solis lumine adducti, se aperiant; arte quali *mimosa* tactum etiam mollissimum reformidet frondesque teneras in sese contrahat; artificio quam admirabili etiam vites, natura caducae, claviculis suis adminicula quaedam tamquam manibus complectantur, et quasi animantes a terra sese altius erigant. Quam dilucide demonstrat, quicquid terra gignit, secundum ea quorum in medio vivit, velut ipsos animantes, naturam suam sensim variare ac mutare. Idem neque per membranam tenuissimam aquae sorbendae rationem, quae *osmosis* dicitur, neque cellularum motum, qui *chemotaxis* nuncupatur, inexploratum reliquit. Etiam animalium minutissimorum quae *bacteria* nominantur motus varios quam subtiliter moderatur, et in ipsum exitium quam insidiose pellicit. Nuper a Societate Regia Londinensi in Britanniam vocatus, propediem (nisi fallor) ostendet, in eis rebus quas terra gignit, quinam sit ipse motus fons et origo; quo potissimum modo sucus ipse quem e terra trahunt, spiritus ipse quem e caelo hauriunt, quasi vim quandam mittat liberam, unde motuum inter se diversorum varietas tam magna exoriatur. Quid est in his omnibus, Academici, (ut Ciceronis utar verbis) "quid est, in quo non naturae ratio intellegentis appareat"?

Praesento vobis scientiae botanicae praeceptorem illustrem, Professorem Lipsiensem, WILLELMUM PFEFFER.

MR. WILLIAM HOULDSWORTH, Rozelle, Ayr, has just intimated his intention of presenting to the University of Glasgow a sum of 5600*l.*, so invested as to yield an annual income of 150*l.*, in order to endow a research studentship in connection with the Faculty of Science. The sum of 120*l.* is to be paid annually to the research student on the foundation, the remainder to be used to defray laboratory expenses and materials in connection with his work, and the fees of such science classes as he may attend. To be eligible for appointment candidates must have studied at least two years in the University of Glasgow, and the appointment is to be made in the manner iaid down by the ordinance regarding research students and fellows. The period of tenure is to be two years, during which the holder must prosecute research studies in the Natural Philosophy department with diligence and regularity. Mr. Houldsworth has taken this method of showing his interest in the welfare of the University and the advancement of science, and his recognition of the distinguished services rendered to scientific research by Lord Kelvin during a professorship of fifty years.

THE London University Commission Bill passed through Committee of the House of Lords on Thursday last. The Duke of Devonshire announced that the names of the Commissioners were the same as those in the Bill of last year with one exception, and were as follows:—Lord Davey (chairman), the Bishop of London, Sir William Roberts, Sir Owen Roberts, Prof. Jebb, M.P., Prof. Michael Foster, and Mr. E. H. Busk (chairman of Convocation). It was agreed that the powers of the Commissioners should continue till the end of 1899 instead of 1898. With the object of securing for the Agricultural College of Wye, established by the County Councils of Surrey and Kent, the advantages derivable under the Bill, Lord Stanhope moved an amendment to the clause referring to the powers and duties of the Commissioners, and he was supported by Lord Ashcombe and Lord Thring. The amendment was not pressed on a promise being given by the Duke of Devonshire that if it were found to be possible without injuriously disturbing the compromise embodied in the Bill he would endeavour on the report to insert words to meet the claims of Wye College.

REPLYING to a question asked by Lord Norton in the House of Lords on Thursday last, the Duke of Devonshire said he hoped the Bill of the Government relating to secondary education would be introduced after Easter. He added: "It is not, and never has been, the intention of the Government to do anything in the nature of what may be called establishing secondary education all over the country. Any measure which we propose will be solely for the purpose of organising in a better way that which already exists, and, possibly, for supplementing it to a certain extent. That what is being done by county authorities, or municipal bodies, or private individuals is something to be done by the Government, is not an idea which has ever been entertained by the Government. No doubt a certain amount of the 800,000*l.* which has been given to be principally expended on technical education may have been at the outset misapplied, and perhaps a certain portion of it has been wasted; but, on the other hand, I believe that a very large portion of it is now being most usefully employed, and with very great advantage, to the various localities. It is not dependent entirely upon the will and pleasure of the County Councils. Almost every County Council has, for the purpose of administering this grant, established an educational committee, which does not usually consist solely of members of the County Council, or need not consist solely of members of County Councils. Those bodies are gradually acquiring a great deal of experience, and I believe that in a great many centres they are at present doing very valuable work."

SCIENTIFIC SERIALS.

IN the January number of the *Quarterly Journal of Microscopical Science*, Mr. E. A. Minchin gives a valuable addition to our knowledge of asconid sponge morphology in a paper on the origin and growth of the triradiate and quadriradiate spicules in the family Clathrinidæ. Mr. Minchin here produces full histological evidence of his discovery of the composite origin of these two kinds of spicules; he shows that the triradiate spicules are formed by trios of dermal cells which immigrate from the epithelium to the interior; by the division of each cell a sextet is formed, and the spicule appears with each of its rays corresponding to two sister cells of the sextet. With regard to the quadriradiate spicules the three basal rays develop exactly as do the triradiate spicules, but the fourth or gastral ray is secreted by a mother cell derived from a porocyte. The spicules are crystalline as a whole, but the rays are non-crystalline so long as they are distinct from one another, and may remain so for some little time after union has taken place; the crystallisation appears

to start from the secondary deposit which unites the rays at the centre. Much skill and care have been bestowed on the beautiful drawings illustrating these researches, and they are admirably reproduced in an excellent series of plates.—Prof. MacBride, in a paper on the early development of Amphioxus, shows the similarity between the cœlomic chambers of Amphioxus and Balanoglossus, and homologises the metapleural lymph canals of the former with portions of the collar pouches of the latter; in consequence of this he revives Bateson's comparison of the atrial folds of Amphioxus with the posterior collar folds of Balanoglossus.—Mr. Shipley gives an account of a new Tapeworm from a bird in the Sandwich Islands.—Dr. Willey gives the diagnosis of a new genus of Enteropneusta.—Prof. Haswell describes a Turbellarian from deep wells in New Zealand.—Prof. Ray Lankester, in a note on the development of the atrial chamber of Amphioxus, corrects Prof. MacBride's statements with regard to the well-known researches by himself and Dr. Willey on the development of the atrial chamber.

Bulletin of the American Mathematical Society, February.—The number opens with an account of the fourth annual meeting of the Society on December 29, 1897. After the election of the new Council—Prof. S. Newcomb being re-elected President—eleven papers were presented; of some of these abstracts are given, and the journals in which they have appeared, or will appear, are named.—Prof. Woodward's paper on the differential equations defining the Laplacian distribution of density, pressure, and acceleration of gravity in the earth presents an improved mathematical method for the treatment of the problem, previous methods being deemed by the author to be lacking in elegance and compactness.—The following are to appear in the *American Journal of Mathematics*—viz. on some points of the theory of functions, by Prof. Chessin; and point-transformation in elliptic coordinates of circles having double contact with a conic, by Dr. Lovett. A second paper by Dr. Lovett, entitled "Certain invariants of a plane quadrangle by projective transformation," will be published in the *Annals of Mathematics*. It is a contribution to the theory of a system of 4-coplanar points, and shows among other things how the group theory may be made to yield the details of elementary geometry.—Prof. Newcomb's presidential address, given *in extenso*, treats of the philosophy of hyperspace. "There is a region of mathematical thought," he remarks, "which might be called the fairyland of geometry. The geometer here disports himself in a way which, to the non-mathematical thinker, suggests the wild flight of an unbridled imagination rather than the sober sequence of mathematical demonstration." He defines his hyperspace as being, in general, space in which the axioms of the Euclidean geometry are not true and complete. Curved space and space of four or more dimensions are completely distinct in their characteristics, and must therefore be treated separately. Prof. Newcomb's views have already been stated in our columns, and the present address is an interesting sequel to them up to date.—Another of the papers, viz. orthogonal group in a Galois field, by Dr. L. E. Dickson, is also given here. The term *orthogonal*, in the present connection, is defined, and a remark of Jordan's shown to be not exact (*Traité des Substitutions*, p. 169, *ll.* 18–21).—We can merely mention that the second meeting of the Chicago Section was held on December 30 and 31, 1897, at which twenty-one papers were read. Brief abstracts are given. From the *Notes* we learn that in the year 1897 the membership of the Society increased from 280 to 301, and the total number of papers read was 88!

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 27.—"On the Zoological Evidence for the Connection of Lake Tanganyika with the Sea." By J. E. S. Moore, A.R.C.S.

The results of the morphological examination of the animals obtained during the author's recent expedition to Lake Tanganyika have made it evident that the fauna of this lake must be regarded as a double series, each half of which is entirely distinct in origin and nature from the other. The remarkable Molluscan shells which were brought home by Burton and Speke, form but a small part of the Molluscan section of the more abnormal of these fresh-water stocks. Besides Molluscs, the lake was found to contain fishes, Crustacea, Cœlenterata, and Protozoa, all of which, like Speke's shells, present the most curious marine affinities, and for distinctive purposes the individual members of this unique assemblage of quasi-marine fresh-water organisms are described as members of the Halolimnic group.

The distribution of the aquatic faunas occurring in Lakes Shirwa, Nyanza, Kela and Tanganyika, all of which were visited and dredged during the expedition, shows (together with what is already known respecting the Victoria Nyanza and the more northern lakes) that the Halolimnic animals are exclusively restricted to Tanganyika. It is thus rendered inconceivable that the Halolimnic forms can have arisen through the effect of ordinary conditions operating upon the population which the lake originally possessed. For the same reasons, it becomes equally clear that the Halolimnic animals cannot be regarded as the survivors of an old fresh-water stock. Since, if we accept either of these suppositions, we are bound by the facts of distribution to believe, also, that the Halolimnic animals have been destroyed in every African lake but one; a supposition which may be ingenious, but which, when the number of lakes existing in the African interior is fully realised, becomes grotesque.

Apart from the physical difficulties which the present effluent of Tanganyika presents to the ingress of organisms from the sea, it is impossible to regard the Halolimnic forms as having recently transmigrated thither from the ocean, since none of these animals are exactly similar to any marine organisms at present known. They must, therefore, have been in Tanganyika long enough to modify into their present condition from the living oceanic species which we know, or they retain the characters of a sea-fauna that has elsewhere become extinct.

The delicate nature of the lake Medusæ, and the fact that most of the Halolimnic Molluscs are exclusively deep-water forms, renders it impossible that these organisms can have made their way into Tanganyika at any time under the physical conditions which now exist.

The facts of distribution and the general characters of these forms, as well as the geographical conditions of the lake in which they are now found, lead then to the conclusion that the Tanganyika region of Central Africa must have approximated to a deep arm of the sea in ancient times.

This view is finally confirmed by the details of the anatomy of the Halolimnic animals themselves. For some of the individual Molluscs of this group combine the characters of several of the most modern marine genera. The Halolimnic fauna of Tanganyika, therefore, cannot represent an extinct fresh-water stock, since the characteristic fresh-water organisms of the present day (which would in such a case have to be regarded as their linear descendants) possess the anatomy of vastly older types.

To the Halolimnic animals there thus attaches the unique interest that they themselves constitute the few surviving indications of an old sea which once extended far into the African interior, and which, judging from the characters of the animals it left behind, must have retained its connection with the ocean at least as late as Tertiary times.

These conclusions, it will be observed, are directly in opposition to the views which were originated by Murchison, and which depict the African interior as never having been below the sea at least since the New Red Sandstone age.

February 17.—"On the Magnetic Deformation of Nickel." By E. Taylor Jones, D.Sc.

The experiments were made with a view to further testing a result arrived at on a former occasion by the author, viz. that the magnetic contraction of a long nickel wire was approximately proportional, when allowance was made for the effects of Kirchhoff's system of stresses, to the fourth power of the magnetisation.

In order to vary, if possible, the conditions of the experiments some preliminary measurements were made to find out whether temperature had any marked influence on the magnetic contraction. The temperature of the specimen was raised by allowing warm water to flow through the water-jacket of the magnetising coil. It was found that at low field-strengths (up to about 90 C.G.S.) the magnetic contraction was greater at 56° C. than at 19° C.; at higher fields the contraction was greater at the lower temperature, the difference being about 6 per cent. at the field 330 C.G.S.

Repeated measurements showed that the contraction at any

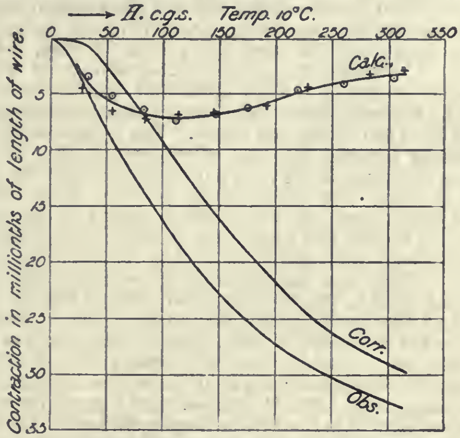
temperature and field was not constant, but diminished as time went on. In order to eliminate this effect as far as possible the subsequent measurements were made in the following order:—

(1) The change of magnetisation accompanying a certain increase of tension, and the magnetisation at the mean tension (at 10° C. and 55° C.).

(2) The magnetic contraction at the mean tension (at 10° C. and 55° C.).

(3) The measurements of (1) repeated.

(4) The magnetic contraction at 10° C. Values of the expression deduced from Kirchhoff's theory were calculated from (1) and (3) for both temperatures, and the mean compared with the observed contraction (2). The results are shown (for 10° C.) in the accompanying diagram. The calculated contraction is much



less than the observed, and the difference is approximately proportional to the *sixth* power of the magnetisation. A similar result was obtained by comparing the mean observed contraction at 10° C. (2) and (4), with the calculated value deduced from (3). All the quantities measured showed a diminution as time went on, especially the influence of tension on magnetisation at low fields. The calculated values of the contraction deduced from (1) are indicated in the diagram by the points + + + . . .; those deduced from (3) by the points ⊙ ⊙ ⊙ . . . At the field 275 C.G.S. the magnetic contraction was about 16 per cent. less than it was four months earlier.

Physical Society, March 11.—Mr. Shelford Bidwell, President, in the chair.—Prof. J. D. Everett gave a communication on dynamical illustrations of certain optical phenomena. The first part of the paper deals with the properties of a series of equal particles attached at equal intervals to an uniform stretched elastic weightless string. Their free simple-harmonic modes of wave-motion are first investigated. The highest frequency occurs when the wave-length is double that of the common distance a. As the wave-length increases from $2a$ to infinity, or diminishes from $2a$ to a, the frequency tends to zero. To every wave-length λ_1 between $2a$ and infinity, there corresponds a wave-length λ_2 between $2a$ and a, such that $a/\lambda_1 + a/\lambda_2 = 1$. The frequency is the same for λ_2 as for λ_1. Further examination shows that the difference of wave-length between these two solutions is only apparent, and that, so far as the movements of the particles are concerned, waves of length λ_1 travelling in one direction, are identical with waves of length λ_2 travelling in the opposite direction. The same is true if $a/\lambda_1 + a/\lambda_2$, instead of being unity, is equal to any integer. On the other hand, if the difference between a/λ_1 and a/λ_2 is an integer, the two sets of waves travel in the same direction. Any simple-harmonic wave-motion of the system of particles may thus be regarded as having any one of an infinite number of wave-lengths. When one particle of the system is constrained to a S.H. motion, of frequency not exceeding that which corresponds to $\lambda = 2a$, the whole system will ultimately vibrate in equal waves. When the frequency of the constrained particle exceeds that due to $\lambda = 2a$, the ultimate state will be S.H. motion with exact opposition of phase between successive particles. The simultaneous displacements of the particles at any instant, as we travel away from the constrained particle in either direction, form a diminishing geometrical progression with signs alternately plus and minus. Expressions are investigated for the constraining force and for the ratio of the energy of the system (consisting of an unlimited number of particles) to the energy of the constrained particle. The second part of the paper deals with pendulums. (1) Sympathetic pendulums, such as two equal pendulums suspended from the same support. (2) Double pendulums, *i.e.* one simple pendulum suspended from another. In each case the investigation consists in seeking a mode of vibration in which the two bobs have either identical or opposite phases, so that their displacements are in a constant ratio, positive or negative. In every case there are two such modes, one with a positive and the other with a negative ratio. As regards the sympathetic pendulums: when they are equal in mass and length, the periods for the two modes are approximately equal, and the displacement of each pendulum follows the law of a "curve of beats," the excursions are largest for one pendulum when they are smallest for the other. As regards the double pendulum: when the lower mass is much less than the upper, there exist, in like manner, motions following the law of beats, provided that, to start with, one bob is at rest in the zero position, and the other at rest in an extreme position. If the lengths of the two strings are decidedly unequal, one fundamental mode has approximately the period of the upper, and the other the period of the lower pendulum. In the former, the displacements of the two bobs are comparable; in the latter, the displacement of the upper is small compared with the lower. The bearing of these conclusions is pointed out, first, on Lord Kelvin's conclusions respecting a suspended clock; and, secondly, on Lord Rayleigh's assertion (frequently quoted in connection with anomalous dispersion) respecting the influence on a heavy pendulum of a much lighter one suspended from it. To obtain the phenomenon of beats in perfection, the upper string must be slightly longer than the lower, and the ratio of *difference* to *sum* of lengths must equal the ratio of lower mass to upper. The beats thus obtained explain the experiment described in the second edition of "Rayleigh on Sound," § 62. Sellmeier's application of the beats of double pendulums to explain fluorescence is briefly described. Stokes explains fluorescence by the analogy of the chain of equal particles discussed in the first part of the paper. Forced vibrations quicker than the critical frequency are produced by the action of the vibrating ether on the fluorescent body; and when the body is left to itself, its subsequent motion is made up of S.H. components, all of which are below the critical frequency.—Prof. R. A. Lehfeldt then read a paper on the properties of liquid mixtures. In a previous communication (*Phil. Mag.* 5, vol. xl. p. 398) the author followed out the consequences of a certain thermodynamic relation between the composition of a liquid mixture and that of the vapour in equilibrium with it, and the saturation-pressure of the system. More stable compounds are now chosen, viz. benzene and toluene mixed with carbon tetrachloride, as types of normal organic compounds; and benzene and toluene mixed with ethyl alcohol as types of a so-called "associated" liquid. These experiments have been carried out in the Davy-Faraday laboratory. The measurements come under two distinct groups: (1) vapour-pressure, (2) composition of vapour. They were made separately, on material from the same source, prepared identically. To measure the vapour-pressure of the mixtures, the "dynamic" method was adopted. An experiment consists in weighing out a mixture, taking its refractive-index by a Pulfrich refractometer, placing it in a boiling tube, and after adjusting temperature and pressure, taking observations at different temperatures on a rising scale, and then on a falling scale. The refractive-index of the residue is again measured; this is always used for checking the composition of the mixtures. For determining the composition of the vapour over liquid mixtures, the method used is to distil a little of the mixture and analyse the distillate. The apparatus is arranged so that the distillate can be drawn off by a tap, as required. The author criticises the results of Linebarger (*Jour. Amer. Chem. Soc.*, vol. xvii.), and also those of Margules (*Wien. Ber.*, vol. civ.). Linebarger states that the partial pressure of benzene and toluene in mixtures, is simply proportional to the molecular percentage present. This conclusion, the author considers, is only roughly true; the partial pressure of the hydro-carbon vapour is not necessarily linear in mixtures; hence, the rule proposed by Linebarger for determining the molecular weight is incorrect.—The President proposed votes of thanks to the authors, and the meeting was adjourned until March 25.

Chemical Society, March 3.—Prof. Dewar, President, in the chair.—The following papers were read:—Preparation of anhydrous hydrogen cyanide and carbon monoxide, by J. Wade and L. C. Panting. On dropping a mixture of equal volumes of sulphuric acid and water on to 98 per cent. potassium cyanide, hydrogen cyanide is evolved in nearly theoretical amount; with concentrated sulphuric acid, nearly pure carbon monoxide is evolved in almost theoretical quantity.—Preparation of some nitro- and amido-oxylutidines, by J. N. Collie and T. Tickle. The authors have prepared mononitro- and monamido-derivatives of pseudolutidostyril and ethylic pseudolutidostyrilcarboxylate by the ordinary methods.—Production of some nitro- and amido-oxylutidines. Part ii., by Miss L. Hall and J. N. Collie. Nitrolutidone is obtained by nitrating lutidone with a mixture of nitric and sulphuric acids; the platinichloride of amidolutidone, when warmed with hydrochloric acid, seems to yield a salt of propine diamine, $CMe(NH_2) : CH(NH_2)$.—On benzene hexabromide, by F. E. Matthews. The author was unable to prepare the second benzene hexabromide described by Orndorff and Howells, and could not prepare either the hexachloride or hexabromide of bromobenzene.—Note on the action of bromine on benzene, by J. N. Collie and C. C. Frye. The authors have succeeded in proving the presence of ortho-compounds in the product of the action of bromine on benzene in presence of sunlight.—Note on manganic salts, by C. E. Rice. The author shows that the decomposition of manganic chloride in solution into manganous chloride and chlorine is reversible.—Some chemical properties of concentrated solutions of certain salts. Part i. Potassium carbonate, by W. C. Reynolds. By crystallising a concentrated solution of potassium carbonate containing the chloride, nitrate, or acetate of various metals, the author has obtained crystalline double salts of the following compositions: $CuK_2(CO_3)_2$, $CuK_2(CO_3)_2,H_2O$, $CuK_2(CO_3)_2,4H_2O$, $MnK_2(CO_3)_2,4H_2O$, $FeK_2(CO_3)_2,4H_2O$, $CaK_2(CO_3)_2$, $Bi_2OK_4(CO_3)_4,H_2O$, $CoK_2(CO_3)_2,4H_2O$, $NiK_2(CO_3)_2,4H_2O$, $MgK_2(CO_3)_2,4H_2O$, and $AgKCO_3$.—The colouring matters of the Indian dye-stuff *Delphinium zalil*, by A. G. Perkin and J. A. Pilgrim. The dried flowers and stems of *Delphinium zalil* are used in India under the name of "asbarg" for producing a yellow colour on alum-mordanted fabrics. Three colouring matters exist as glucosides in the plant, namely isorhamnetin, quercetin, and a third which was not obtained pure.—Some metallic salts of natural yellow colouring matters, by A. G. Perkin and P. J. Wood. Quercetin, morin, fisetin and myricetin decompose potassium acetate in alcoholic solution with formation of sparingly soluble metallic derivatives; luteolin, apigenin, chrysin and gentisin do not do so.—The interaction of magnesium and solution of copper sulphate, by E. Divers.

Royal Microscopical Society, February 16.—Mr. A. D. Michael, Vice-President, in the chair.—Mr. J. E. Barnard said that when he gave his demonstration at the November meeting, on the application of the electric arc to photomicrography, Mr. Nelson suggested that it would be of interest if he would show some lantern slides taken in that way; he had accordingly brought a few examples for exhibition on the screen. These included a series showing ringworm fungi, which he thought would have some interest apart from the method by which the photographs had been produced. A number of slides were then shown, illustrating the appearance of the fungi in various stages and under conditions in which the external portions, or internal structure of the hair of man and animals had been attacked, and their appearance when cultivated artificially. The photographs were from microscopical preparations lent by Dr. T. Colcott Fox. Other slides were shown of the bacilli of anthrax, tuberculosis, typhoid fever, bubonic plague, &c. Dr. Hebb concluded some remarks by saying that he did not know that he had ever seen these subjects so beautifully illustrated as he had that evening. Mr. T. Charters White said he could endorse all that fell from Dr. Hebb. For high amplification he did not know that he had seen anything so sharply defined, especially in the case of the Podura scale magnified 6000 diameters. The Chairman said no one could fail to be struck by the clear manner in which these minute objects had been shown. [Two of the pictures, with a short account of the light used in their production, have already appeared in these columns (p. 448).—Mr. T. Charters White read a paper on microcrystallography, which he illustrated by the exhibition on the screen of a number of slides of the crystals described. He had selected them to show how large a number of beautiful forms might be obtained from the same salt by causing it to crystallise under different conditions. Mr. White further illustrated the subject by exhibiting the formation of crystals under the microscope. The Chairman thought it quite possible that when they came to examine these crystals very carefully they would find that the ultimate form did, after all, agree with the typical form, but it was remarkable to see how other forces could modify these forms.—The Chairman said they had another paper on the agenda, on Foraminifera taken chiefly from shallow water in the Malay Archipelago, by Mr. Durrand.

Royal Meteorological Society, February 16.—Mr. F. Campbell Bayard, President, in the chair.—Mr. E. Mawley gave a report on the phenological observations for 1897, from which it appeared that there had been a marked absence of very exceptional weather during the past phenological year, the most noteworthy features affecting vegetation being the persistent rains in March and the three dry periods of May, July and October. Until about the middle of May wild plants appeared in blossom in advance of their usual time, but throughout the rest of the flowering season they were all somewhat behind their average dates in coming into bloom. The heavy rainfall in the early spring favoured the hay, which proved the only really abundant farm crop of the year, but greatly impeded the sowing of spring corn. The cereals were, however, much benefited later on by the warm, dry and brilliant weather of the summer. Taking the country as a whole, oats proved a good crop, barley an average one, while the yield of wheat was somewhat under average. There were also fair crops of roots and potatoes. It was owing more to the dry spring and summer and the sunless autumn of the previous year, than to the moderate frosts and cold winds of the spring of 1897, that the fruit crop was such a very light one. Apples, pears and plums, and especially the latter, yielded badly, while the small fruits were in most districts only average crops.—Mr. Hopkinson read a paper on monthly and annual rainfall in the British Empire 1877–96. In this the author gave particulars of the mean monthly and annual rainfall, and the number of rainy days, at the following twelve stations in the British Empire, viz. London, England; Port Louis, Mauritius, Calcutta and Bombay, India; Colombo, Ceylon; Adelaide and Melbourne, Australia; Wellington, New Zealand; Toronto and Winnipeg, Canada; Kingston, Jamaica; andMalta.

Linnean Society, February 17.—Dr. A. C. L. Günther, F.R.S., President, in the chair.—Dr. Kakichi Mitsukuri, Professor of Zoology, Imperial University, Tokyo, was admitted a Foreign Member.—Prof. G. B. Howes, F.R.S., exhibited specimens of Dog-fishes: (1) *Scyllium canicula* from the egg-case, and (2) *Scyllium catulus* prematurely hatched, which he had received from Mr. C. W. L. Holt, of the Marine Biological Laboratory at Plymouth. The specimens showed the dorso-lateral and caudal placoids which led Filippi to propose the species *Scyllium acanthonotum*, shown by Dr. Günther to be based upon a developmental character, and had in recent years been the subject of some interesting speculations by Paul Meyer. For comparison he exhibited also an embryo from the purse of *Callorhynchus antarcticus*, showing a similar set of organs, and gave reasons for surmising that they are not merely transitory vestiges, but of service to the animal while encapsulated within its egg-case. Some additional remarks were made by the President.—Mr. J. E. Harting exhibited a nearly white variety of *Mus rattus* recently obtained in Carnarvonshire, and made some remarks on the difference of haunts and habits in the two species *M. rattus* and *M. decumanus*, and on their usual antagonism. In reply to Mr. H. J. Elwes on the question of occasional hybridism, he stated that no well-established case of the kind had been recorded, although some years ago Mr. Barrett Hamilton had described (*Zool.*, 1888, p. 141) a suspected hybrid which was partly brown in colour, partly black, and exhibited some other intermediate characters. He referred to the so-called Irish rat, *Mus hibernicus* of Thompson, which was now regarded as a permanent black variety of *Mus decumanus* not confined to Ireland.—Mr. F. N. Williams read a paper on *Arenaria*, one of the larger genera of Caryophyllaceæ, which now includes a considerable number of species. *Alsine* and others, usually included as sections of the genus, he thought should be regarded as distinct genera; *Alsine* and *Arenaria* being distinguished by the same cardinal character which separates *Lychnis* from *Silene*.—Mr. G. S. West read a paper on the histology of the salivary, buccal, and Harderian glands of the *Colubridæ*, with notes on their tooth-succession and the relationship of the poison-duct.

Geological Society, February 23.—W. Whitaker, F.R.S., President, in the chair.—On some submerged rock-valleys in South Wales, Devon, and Cornwall, by T. Codrington. The author described various valleys in which the solid rock was reached at a considerable depth below sea-level, on the sides of Milford Haven and in the Haven itself; beneath the Tivy, Tawe, and Neath, the Wye, the Severn, the Bristol Avon, the Dart, the Laira, the Tavy, the Tamar, and other rivers. In the case of the Dart the rock-bottom had been found at one place at a depth of 110 feet below low-water level, and in the case of other rivers at varying depths less than this. The deposits showed that some of the infilling took place after the period of submerged forests, and much before this, for frequent cases of glacial deposits filling the bottoms of these submerged valleys were recorded. The fact that in the Solent and Thames the glacial deposits bordered the sides of the valleys, and did not occur at the bottom as in the case of the valleys described in the paper, indicated that the latter were older than the former, though they presented features similar to those of some of the valleys of the North-east and North-west of England.—Some new carboniferous plants, and how they contributed to the formation of coal-seams, by W. S. Gresley. The author, in a paper published in abstract in the Society's *Quarterly Journal* for May 1897 (vol. liii. p. 245), argued that certain brilliant black laminæ in coal, and similar materials found among some mechanical sediments of the coal measures, pointed to the former existence of an aquatic plant. In the present communication he described structures in the pitch-coal laminæ of bituminous coal and in the glossy black layers of anthracite which he believed to be indications of two other kinds of plants, and stated that he had examined structures which might be due to some other kinds of vegetation.

Zoological Society, March 1.—Dr. W. T. Blanford, F.R.S., in the chair.—Mr. G. A. Boulenger, F.R.S., exhibited, and made remarks upon, a living hybrid newt, the result of a cross between specimens of a hybrid *Molge cristata* × *M. marmorata* and the former species, which had been reared at Argenton-sur-Creux by M. R. Rollinat.—Mr. F. E. Beddard, F.R.S., read a paper on certain points in the anatomy of the cunning Bassarisc (*Bassariscus astutus*), as observed while dissecting a specimen which had died in the Society's menagerie, and called special attention to certain points in the viscera and in the form of the brain in which *Bassariscus* agreed with the arctoid carnivora.—Mr. G. A. Boulenger, F.R.S., read a paper entitled "a revision of the African and Syrian fishes of the family *Cichlidæ*, part I." The author had come to the conclusion that the African and Syrian fishes of this family were, so far as was known, represented by nine genera.—A communication was read from Prof. B. C. A. Windle and Mr. F. G. Parsons containing the second part of a memoir on the myology of the terrestrial carnivora. The present portion dealt with the muscles of the hind limb and the trunk in various species, which, in many cases, seemed to give good indications of their affinities.—A communication from Dr. A. G. Butler on the Lepidoptera collected by Mr. G. A. K. Marshall in Natal and Mashonaland in 1895 and 1897 was read.

PARIS.

Academy of Sciences, March 7.—M. Wolf in the chair.—Chemical actions exerted by the silent discharge. Aldehydes and nitrogen, by M. Berthelot. Mixtures of nitrogen with various substances of aldehyde function, including acetaldehyde, propionic aldehyde, acetone, methylal, aldol, paraldehyde, trioxymethylene, formaldehyde, camphor, benzaldehyde, salicylic aldehyde, and furfurol were submitted to the action of the silent discharge for periods varying from eight to twenty-four hours. The nitrogen absorbed was measured, and the gases produced analysed. The solid and liquid products were not obtained in quantities sufficient for analysis.—Chemical action of the silent discharge. Organic acids and nitrogen, by M. Berthelot. The acids studied were formic, acetic, propionic, crotonic, benzoic, succinic, maleic, fumaric, phthalic, camphoric, glycollic, lactic, malic, tartaric, oxybenzoic, pyruvic, levulic, and dehydracetic acids.—Observations relating to the chemical action of the silent discharge on dielectric liquids, by M. Berthelot. The liquids examined were alcohol, olive oil, and essence of turpentine. Alcohol gave a mixture of hydrogen and ethane.—Action of calcium sulphate upon some haloid salts of the alkalies, by M. A. Ditte. A study of the equilibrium produced in aqueous solutions containing calcium sulphate, and varying proportions of alkaline chlorides, bromides, and iodides.—On the number and symmetry of the fibro-vascular bundles of the petiole as a measure of the perfection of vegetable species, by M. A. Chatin.—On the results given by a seismograph installed at Grenoble, by M. M. Lévy. The slight earthquake shock noticed in the valley of the Po on March 4, was clearly shown on the seismographs (Kilian and Paulin, Angot) at Grenoble.—On the absorptive power of lampblack for radiant heat, by MM. Crova and Compan. It is usually assumed that for a given flux of radiant energy the absorptive power of a layer of lampblack is equal to unity. This, however, is not necessarily the case, the coefficient of absorption varying between narrow limits according to the nature of the deposit and its mode of application. A layer of black, applied in the ordinary way, may have an absorptive power as low as 0·9. The application of several layers, each washed with alcohol and then dried, gives a more complete absorption, the coefficient after some six deposits, rising to ·98. Fewer deposits of platinum black are required to reach the same limit.—Report on a memoir of M. Gonnessiat, entitled "Researches on the law of variations of latitude," by M. Radau.—On the "Histoire celesté du 17e siècle" of Pingré, by M. G. Bigourdan.—Note on the ellipsoid of Jacobi, by M. P. Krüger.—On the determination of the group of rationality of linear differential equations of the fourth order, by M. F. Marotte.—On conjugated congruences of pencils C, by M. C. Guichard.—On the invariants of linear partial differential equations of two independent variables, by M. J. Le Roux.—On a problem of Riemann, by M. Ludwig Schlesinger.—On certain first integrals of some dynamical equations in two variables; application to a particular case of the problem of three bodies, by MM. J. Perchot and W. Ebert.—Researches of precision on the infra-red dispersion of quartz, by M. E. Carvallo. The dispersion was measured by means of a bolometer; the results differ appreciably from those of Mouton, but show a remarkably close agreement with figures calculated by means of an extrapolation formula of Mace de Lépinay, derived from observations in the visible spectrum and ultra-violet.—Influence of soft iron on the mean square of the difference of potential at the extremities of a bobbin traversed by a high-frequency current, by M. H. Pellat.—On the temperature of incandescent lamps, by M. P. Janet. The variation of the resistance of the lamp as a function of the difference of potential at the ends of the filament is measured, and also the variation in the resistance of a cooled lamp as a function of the time. From these, with the weight of the filament, the temperature can be deduced, assuming that the filament is composed of pure carbon. Four lamps gave concordant figures, namely 1610°, 1630°, 1620°, and 1720° C.—Some properties of kathodes placed in a powerful magnetic field, by M. André Broca. The experiments lead to the conclusion that there are two kinds of kathode rays, one of which rotates round the line of force of the magnetic field, and the other which follows this line of force.—Researches on nickel-steel. Variations of volume of irreversible alloys, by M. C. E. Guillaume.—Researches on the magnetic properties of nickel-steel, by M. Eugène Dumont. A determination, in absolute values, of the magnetic permeability of twelve samples of nickel steel containing from 26 to 44 per cent. of nickel, in fields varying from 14 to 50 C.G.S. units, and at temperatures between −78° and 250° C. The results are expressed graphically in three sets of curves.—Preparation of beryllium by electrolysis, by M. P. Lebeau. The pure metal is most conveniently obtained by the electrolysis of the fused double fluoride of sodium and beryllium by a current of six amperes, and potential difference of 35 to 40 volts.—Chemical estimation of carbon monoxide in the air, even in the smallest traces, by M. Maurice Nicloux. The method is based upon the fact that carbon monoxide is oxidised by iodic anhydride at 150°, giving carbonic acid and iodine, the latter, representing the carbonic oxide present, being measured by a colorimetric method.—On the dissociation of the carbides of barium and manganese, by MM. Gin and Leleux. These two carbides, at the highest temperatures of the electric furnace, behave similarly to calcium carbide; not being volatile, but dissociated into the metal and carbon.—Researches on the explosion of mixtures containing marsh gas by electric currents, by MM. H. Couriot and J. Meunier. There is no danger of explosion of mixtures of air and methane, by wires raised to incandescence by an electric current. It is only when the wire melts, and a spark passes, that an explosion is determined.—On the preparation and etherification of asymmetrical dimethylsuccinic acid, by M. E. E.

Blaise.—On the synthetical isoborneols, their identity with fenoilic alcohols, by MM. G. Bouchardat and J. Lafont.—On the partial decomposition of chloroform in the organism, by MM. A. Desgrez and M. Nicloux. A reply to the criticism of M. de Saint-Martin. Normal blood gives on analysis a small proportion of carbon monoxide. This amount is notably increased in the blood of animals under chloroform.—A true mucin produced by a fluorescent pathogenic bacillus, by M. Ch. Lepierre.—Action of the bacterium of sorbose upon polyhydric alcohols, by M. Gabriel Bertrand. Alcohols show very different behaviour when treated with the sorbose bacillus; some, such as glycol, xylite and dulcite, resisting the oxidising action completely; others, glycerine, sorbite, mannite, being readily oxidised to ketones.—Influence of the medium upon variations in the Protozoa, by M. J. Kunstler.—The larva of the sponges and homologation of the leaflets, by M. Yves Delage.—On a new type of Copepod, by M. Jules Bonnier. The new type, to which the name *Pionodesmotes phormosomæ* is given, was found by the Prince of Monaco in one of the scientific voyages of the *Princess Alice*.—On a cereal of the Soudan, by M. Dybowski.—A prehistoric station at Mount Huberville, near Valognes, by M. Le Nordez.

DIARY OF SOCIETIES.

THURSDAY, March 17.

Royal Society, at 4.30.—The Croonian Lecture will be delivered by Prof. Wilhelm Pfeffer, For. Mem. R.S. On the Nature and Significance of Functional Metabolism (Betriebs-stoffwechsels) in the Plant.
Royal Institution, at 3.—Magnetism and Diamagnetism: Prof. J. A. Fleming, F.R.S.
Linnean Society, at 8.—Natural Selection the Cause of Mimetic Resemblance and Common Warning Colours: Prof. E. B. Poulton, F R.S. —On the Brain of the Edentata, including Chlamydophorus: Dr. Elliott Smith.—On Limnocarpus, a New Genus of Fossil Plants from the Tertiary Deposits of Hampshire: Clement Reid.
Chemical Society, at 8.—The Reduction of Bromic Acid and the Law of Mass Action: Winifred Judson and Dr. J. Wallace Walker.—The Action of Ferric Chloride on the Ethereal Salts of Ketone Acids:—Dr. R. S. Morell and Dr. J. M. Crofts.—Note on the Volatility of Sulphur: T. C. Porter.—Action of Ammonia and Substituted Ammonias on Acetylurethane: Dr. George Young and Ernest Clark.—Cannabinol: T. B. Wood, W. T. N. Spivey, and Dr T. H. Easterfield.—Formation of Oxytriazoles from Semicarbazides: Dr. G. Young, and B. M. Stockwell.
Institution of Civil Engineers, at 8.—Sixth "James Forrest" Lecture, Geology in Relation to Engineering: Prof. W. Boyd Dawkins, F.R.S.
Camera Club, at 8.15.—Some Recent Animal Photographs: Gambier Bolton.

FRIDAY, March 18.

Royal Institution, at 9.—The Bringing of Water to Birmingham from the Welsh Mountains: J. Mansergh.

MONDAY, March 21.

Society of Arts, at 8.—The Thermo-Chemistry of the Bessemer Process. Prof. W. N. Hartley, F.R.S.
Victoria Institute.—A New Babylonian Story of the Flood: Theo. G. Pinches.
Camera Club, at 5.30.—Annual General Meeting——At 8.30.—Travels in Kashmir and Little Tibet: Dr. Arthur Neve.

TUESDAY, March 22.

Royal Institution, at 3.—The Simplest Living Things: Prof. E. Ray Lankester, F.R.S.
Institution of Civil Engineers, at 8.—Calcium Carbide and Acetylene: Henry Fowler.—Extraordinary Floods in Southern India: their Causes, and Destructive Effects on Railway Works: E. W. Stoney.
Royal Horticultural Society.—Horticultural Soils.
Royal Photographic Society, at 8.—The Gum Bichromate Process: Robert Demachy.

WEDNESDAY, March 23.

Society of Arts, at 8.—The Preparation of Meat Extracts: C. R. Valentine.
Geological Society, at 8.—The Eocene Deposits of Devon: Clement Reid.—On an Outlier of Cenomanian and Turonian near Honiton, with a Note on *Holaster altus*, Ag.: A. J. Jukes-Browne.—Cone-in-Cone: Additional Facts from various Countries: W. S. Gresley.

THURSDAY, March 24.

Royal Society, at 4.30.—The Bakerian Lecture will be delivered by Dr. W. J. Russell, F.R.S. Subject: Further Experiments on the Action exerted by certain Metals and other Bodies on a Photographic Plate.
Royal Institution, at 3.—Recent Researches in Electricity and Magnetism: Prof. J. A. Fleming, F.R.S.
Institution of Electrical Engineers, at 8.—Cost of Generation and Distribution of Electrical Energy: R. Hammond.
Camera Club, at 8.15.—Photographic Engraving in Intaglio: Colonel Waterhouse.

FRIDAY, March 25.

Physical Society, at 5.—On the Circulation of the Residual Gaseous Matter in a Crookes' Tube: A. A. Campbell Swinton.—On some Improvements in the Roberts-Austen Recording Pyrometer, and Notes on Thermo-electric Pyrometers: A. Stansfield.
Institution of Civil Engineers, at 8.—Internal Governor Friction H. O. Eurich.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Évolution Individuelle et Hérédité: F. Le Dantec (Paris, Alcan).—Ethnological Studies among the North-West Central Queensland Aborigines: W. E. Roth (Brisbane, Gregory).—Exploration of the Air by means of Kites (Cambridge, Mass., Wilson).—Queen's College, Galway, Calendar for 1897–98 (Dublin, Ponsonby).—Prospecting for Minerals: S. H. Cox (Griffin).—Lehrbuch der Algebra: Prof. H. Weber, Zweite Auflage, Erster Band (Braunschweig, Vieweg).—The Collected Mathematical Papers of Arthur Cayley. Supplementary Volume containing Titles of Papers and Index (Cambridge University Press).—Araneae Hungariae: C. Chyzer and L. Kulczynski, Tome 1 and 2 (2 parts) (Budapestini).—Audubon and his Journals: M. R. Audubon, 2 Vols. (Nimmo).—The Smithsonian Institution, 1846–1896. The History of its First Half-Century: edited by G. Browne Goode (Washington).—Smithsonian Institution. Revision of the Orthopteran Group Melanopli (Acridiidæ): S. H. Scudder (Washington).

Pamphlets.—Field Columbian Museum. Annual Report of the Director to the Board of Trustees for the Year 1896–97 (Chicago).—Ditto. List of Fishes and Reptiles obtained by Field Columbian Museum East African Expedition to Somali-Land in 1896: S. E. Meek and D. G. Elliot (Chicago).

Serials.—Knowledge, March (Holborn).—Botanische Jahrbücher, Fünfundzwanzigster Band, 1 and 2 Heft (Leipzig).—Strand Magazine, March (Newnes).——Engineering Magazine, March (222 Strand).—Rendiconto delle Sessioni della R. Accademia delle Scienze dell' Istituto di Bologna, 1895–96: Ditto, Nuova Serie, Vol. 1, Fasc. 1 to 4 (Bologna).—Katalog der Bibliothek der K. Leopoldinische-Carolinischen Deutschen Akademie der Naturforscher, Achte Liefg., Band ii. 5 (Halle).—Journal of the Institution of Electrical Engineers, March (Spon).—Science Abstracts, January (Taylor).—Bulletin of the Liverpool Museums, February (Liverpool).

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THURSDAY, MARCH 24, 1898.

A BIOGRAPHY OF WILLIAM HARVEY.

Masters of Medicine. William Harvey. By D'Arcy Power, F.S.A., F.R.C.S. Edited by Ernest Hart, D.C.L. Crown 8vo. Pp. xi + 296. (London: T. Fisher Unwin, 1897.)

THERE is probably no name in the roll of European physicians antecedent to our own time so familiarly known as that of the discoverer of the circulation of the blood. Harvey was one of the founders of the modern method of investigating nature, and he takes rank with Galileo and Descartes among the select few who stand out as landmarks in the early history of exact science. His life and work have therefore an enduring interest for all educated men. Dr. Willis's classical biography of Harvey, published twenty years ago, was not cast in a popular mould, and is now almost out of print. It was therefore time, and there was room, for a new life of Harvey; and the late Mr. Hart was fortunate in his selection of Mr. D'Arcy Power for this task. Mr. Power tells us in his preface:

"It is not possible, nor have I attempted, in this account of Harvey, to add much that is new. My endeavour has been to give a picture of the man and to explain in his own words, for they are always simple, racy, and untechnical, the discovery which has placed him in the forefront of the Masters of Medicine."

Notwithstanding this modest disclaimer, Mr. Power has succeeded in collecting a good deal of fresh collateral information which throws much interesting side light on the career and surroundings of Harvey.

William Harvey was born in Folkestone in 1578. He was the eldest son of an opulent Kentish yeoman, and his career was never hampered by pecuniary difficulties. His school-boy days were passed at Canterbury. Thence he migrated to Caius College, Cambridge, where he graduated in arts in 1597, at the age of nineteen. There were at that time no organised Schools of Medicine in Britain, and Harvey had to look elsewhere for the means of prosecuting his medical education. He chose Padua; and became a pupil of Fabricius—the foremost anatomist of his day. Fabricius was then engaged in perfecting his discovery, or rather re-discovery, of the valves of the veins. Fabricius, no doubt, demonstrated the existence of these valves to his class; and it may be inferred that Harvey's interest in the motions of the heart and blood was first awakened by these demonstrations. Fabricius taught that the purpose of these valves was to prevent over-distension of the vessels when the blood passed from the larger into the smaller veins (a double error), whilst they were not needed in the arteries because the blood was always in a state of ebb and flow. It was reserved for Harvey to point out their true use, and to indicate their importance as an anatomical proof of the circulation of the blood.

Harvey spent four years at Padua, and obtained the degree of Doctor of Medicine of that University. He then settled in London, and came rapidly to the front. At the age of twenty-nine he was elected Fellow of the College of Physicians; at thirty-one he became physician to St. Bartholomew's Hospital; at thirty-seven he was chosen Lumleian Lecturer on Anatomy to the College of Physicians. About the same time he was appointed Physician Extraordinary to James I., and subsequently Physician in Ordinary to his successor Charles I. These latter appointments gave Harvey command of the herds of deer in the royal parks, for the purpose of the vivisections and dissections which he practised in the course of his researches on the motions of the heart and blood, and in his investigations on embryology.

Harvey delivered his first course of Lumleian Lectures in 1616. It was in these lectures that he first propounded his views on the circulation of the blood, and demonstrated the anatomical and experimental evidence on which his conclusions were based. These demonstrations were, as he tells us, annually repeated at the Lumleian Lectures for nine successive years. It was only after this long probation that Harvey ventured to give his discoveries to the world. This he did in the form of a small Latin quarto of 76 pages, entitled "Exercitatio Anatomica de motu cordis et sanguinis," published at Frankfort in 1628. This little book is in several respects a remarkable one. It constitutes the earliest record we possess of a really scientific investigation in the domain of biology based on systematic observation and experiment. Although written 270 years ago, the work is essentially modern in tone and method. It is, in fact, the precursor and prototype of the scientific "monograph" of our own day, and stands favourable comparison with the best master-pieces of recent times. In this treatise Harvey established absolutely the fact of the circulation of the blood, and the fact that the heart was the propulsive agent in the movement. But he was unable, from his want of a microscope, to indicate the precise path along which the blood travelled from the terminal arteries to the commencing veins. He erroneously conjectured that the blood percolated the organs and tissues as water percolates the earth and produces springs and rivulets. In less than two years after Harvey's death the improvements in the microscope enabled Malpighi and Leeuenhoek to demonstrate the completion of the circuit of the blood through the capillaries in the web of the frog's foot.

After the publication of his treatise on the circulation, Harvey seems to have concentrated himself, as regards physiological work, on his investigations concerning the generation of animals. He gradually accumulated an immense amount of information on this subject, which was eventually collected together and printed, towards the close of Harvey's life, in a separate volume, under the supervision of his friend Sir George Ent, with the title of "Exercitationes de Generatione Animalium." This book, though many times larger than the treatise on the motions of the heart and blood, is incomparably less satisfying. To the modern reader the reason of this shortcoming is plain enough; Harvey was stopped at every critical point by his want of a larger magnifying power. He had at his disposal only a pocket lens, which magnified perhaps four diameters. He knew nothing, and could know nothing, of the cellular elements of the ovum, nor of the motile filaments which constitute the essence of the spermatic fluid.

The later years of Harvey's life were passed in peaceful retirement. The civil troubles of the time had broken up his household and scattered his patients, but had left his private fortune unimpaired. At the age of sixty-eight he relinquished his appointments and practice, and went to reside with one or other of his brothers, who were wealthy London merchants. He still continued the studies he loved so well—for he had an enduring passion for original research—and maintained his interest in the College of Physicians, to which he was a large benefactor.

Sir George Ent gives us a touching glimpse of him as he appeared in his seventy-third year at the house of his brother Daniel, at Combe.

"I found him, Democritus like, busy with the study of natural things, his countenance cheerful, his mind serene, embracing all within its sphere. I forthwith saluted him and asked if all were well with him? 'How can it,' said he, 'whilst the Commonwealth is full of distraction and I myself am still in the open sea? And truly did I not find solace in my studies and a balm for my spirit in the memory of my observations of former years, I should feel little desire for longer life. But so it has been, that this life of obscurity, this vacation from public business, which causes tedium and disgust to so many, has proved a sovereign remedy to me.'"

Harvey had the satisfaction of living to see his great discovery generally accepted as true. In his old age he was known and honoured throughout the learned world. The College of Physicians erected a statue in his honour. In his seventy-sixth year he was elected president of the College, but declined the honour on the plea of the infirmities of age. Harvey made a peaceful ending in his seventy-ninth year, and was buried in what is now called the "Harvey Chapel" in the parish church of Hempstead in Essex.

Mr. Power has produced a work of permanent value, which is not likely to be superseded. The book is invitingly got up, and is eminently readable. It should attract a large circle of readers both inside and outside the professional pale. W. R.

THE NOTIONS OF CLASSICAL WRITERS ON GEOGRAPHY.

A History of Ancient Geography. By H. F. Tozer. Pp. xvii + 387. (Cambridge University Press, 1897.)

THE want of a short, popular history of classical geography is one which has been long felt, and there is no doubt that the little volume before us will help to fill it. The great work by the late Sir Henry Bunbury, from which Mr. Tozer has so largely drawn, is hardly fitted for a text-book, even for advanced students, for the subject of ancient geography is treated therein in such an exhaustive manner, that no ordinary student who has other subjects to master can ever hope to have sufficient time to study it in the way in which it should be studied. It is somewhat a matter of doubt if Mr. Tozer's, with its three hundred and seventy pages of closely-printed matter, is not too long when the absolute needs of the student are taken into consideration; still the reader will soon see how to pick out the important facts from this pleasantly written treatise, and how to let alone the generalisations and discussions of theories which though interesting enough are not essentials.

The first thing that strikes the reader is the fact that Mr. Tozer has described his work inaccurately; it is not a "History of Ancient Geography," but a "History of Ancient Classical Geography." In days gone by when Oriental studies had not attracted the attention of workers, and the works of Greek and Latin writers were believed to contain all the history of the nations that are past and gone, the title which Mr. Tozer has given to the work would have been well enough; in these days, however, it is misleading. On p. 3 Mr. Tozer says:

"The natural starting-point for such a history must be the shores of the Mediterranean, because the peoples that dwelt in the neighbourhood of that sea first cultivated the science of geography on an extended scale, and it was from that quarter that the information was originally derived which furnished the material for such a study."

Very true as far as it goes, but Egypt and Syria both form part of the Mediterranean coast on the south and east, and yet Mr. Tozer's book tells us next to nothing about either, although so much is now known of both countries, and of the ancient intercourse which existed between them in very old times. Hieroglyphic inscriptions are extant which describe military and other expeditions to the heart of Africa and to the coasts of Arabia from the period of the sixth to the eighteenth dynasty, and several long historical texts which describe the progress of Egyptian arms in Western Asia are so well known as to make it difficult to see why Mr. Tozer has not made use of them. The Tell el-Amarna tablets, which have now been translated into English, French, and German, form a most valuable mine of information for the student of ancient geography, and yet they are not mentioned in Mr. Tozer's work. It is not yet possible to identify all the places the names of which are given in these remarkable documents, but it is quite easy to sketch the main trade and military routes between Egypt and Northern Syria, Western Mesopotamia, &c. About the fifteenth century before our era a certain Egyptian gentleman set out on a journey to Syria and, fortunately for us, he wrote an account of his experience to a friend wherein he detailed the events of the way, the names of the places at which he stayed, and several matters of considerable interest to the geographical student. M. Chabas' edition of the text and translation have been so long before the public that the Mohar's "itinerary" might well have been described by Mr. Tozer. Passing from Egypt to Babylonia and Assyria we think that enough of the early geography of these countries might have been gleaned from the cuneiform inscriptions to make two valuable chapters at least, as well as a tolerably full map.

Speaking of the pygmies (p. 30), Mr. Tozer says:

"We may conclude therefore that the Pygmies of Homer were a real people. . . . The Egyptians might easily have heard of them, and through them the story might have found its way into Greece."

A little searching of Egyptian records would have shown him that the Egyptians knew a great deal about the pygmies, and that King Assa, about B.C. 3300, kept

a pygmy, who had been brought from Central Africa by an Egyptian official called Bāurtet, at his court to dance and to amuse him. About seventy years later another king, Pepi II., sent a despatch to Heru-khuf, his officer commanding the garrison at Aswân or Syene, in which he promised him a greater reward than was conferred by Assa upon Bāurtet if he would go and bring back for him a pygmy "alive and in good health." In the inscription which covers the walls of Heru-khuf's tomb at Aswân (see Schiaparelli, "Una Tomba Egiziana," Rome, 1893), an account is given of the countries through which this brave officer passed, and though it is impossible to identify accurately all the places named, it is perfectly clear that, like the officer Una, he passed through the lands of great trees south of Khartûm, and so on to the districts described by Stanley ("Darkest Africa," i. p. 198; ii. p. 40) and Schweinfurth ("Im Herzen von Africa," ii. p. 131 ff.), to the land of the pygmies. The pygmies were so well known in Egypt that a reference to them is made in a version of the "Book of the Dead" of the sixth dynasty. In the temple at Karnak is an inscription of a later period which states that "the pygmies came from the lands of the south to do service in it," and in it, as in the earlier texts, no doubt can be entertained as to the correctness of the identification of the word *tenk* with "pygmy," for in each case it is followed by the determinative of a thick-set, stunted little man. We are hardly justified in assuming that the Egyptians had any dominion *de facto* in Central Africa, but there is no doubt that as far back as the time of the fifth dynasty they were well acquainted with the products and people of that remote land.

Again, on p. 21 the firmament of bronze which Mr. Tozer describes is nothing but the square metal plate which the Egyptians thought formed the sky and the floor of heaven, which was supported by four mountains or props placed one at each of the cardinal points; from this at night the stars were hung out like lamps, and in fact one of the names for stars, *khabesu*, means nothing but "lamp." The god Atlas is, of course, nothing but a Greek form of the god Shu, whose functions were to lift the sky up from the earth at dawn, to support it during the day, and to let it down again at night. The inscriptions of Egypt would similarly afford many an explanation of passages in Mr. Tozer's book.

Among minor matters it seems to us very doubtful if the name Samos is derived from the Semitic *shamah* (p. 5); the Arabic word *kasdîr* is, of course, derived from the Greek as Dozy showed (Suppl. ii. p. 355, col. 2); it is very doubtful if the names "Asia" and "Europe" are derived from the Assyrian words "to go forth" (of the sun), and "to set" (of the sun); the Peutinger Table was published in its entirety, and it is only Desjardin's description of it which is unfinished (p. 310); and we should have preferred the conical to the elliptical projection of Ptolemy's map given on the plate which faces p. 341. It only remains to say that so far as it goes Mr. Tozer's book is good, and that the classical portions of it have been carefully done; in a new edition we hope that the sources of the information which we obtain from Greek and Latin writers, and which may be traced to hieroglyphic and cuneiform records, will be duly described and set forth.

OUR BOOK SHELF.

La Teoria dei Raggi Röntgen. By Prof. Filippo Re. With two plates. Demy 8vo. Pp. 64. (Palermo: Alberto Reber, 1898.)

In the first three chapters the author discusses the existing theories which regard Röntgen rays as longitudinal waves, molecular streams, and transverse waves of extremely short wave-length. He then proceeds to summarise the various hypotheses which have been advanced to account for the electro-dispersion of these rays, and their capability of bending round obstacles. Chapter vi. deals briefly with other kinds of new rays—namely, Becquerel rays, Le Bon's rays, and Winkelmann and Straubel's "spathofluoric" rays. A comparison of the properties of X-rays with those of Hertzian electric oscillations of considerable length, leads Prof. Re to propound the hypothesis that the former are electric waves of practically infinite length. This hypothesis, the author remarks, has close analogy with that proposed by Sir G. G Stokes at Liverpool, who suggested that Röntgen rays might be due to non periodic disturbances of the ether.

In attempting to show how this theory accounts for the physical properties of Röntgen rays, Prof. Re has, of necessity, left unanswered many questions which naturally suggest themselves, and in answering others has hardly made out a strong case in favour of his views. He attributes absence of reflection to the great penetrating power and diffusion of the rays, and absence of observed polarisation to the impossibility of arriving at any practical result with the means commonly employed; but these explanations can hardly be said to support the present theory more than any other. To account for cryptochröism the author has to suppose that, although the waves are of practically infinite length, their lengths are nevertheless of different magnitudes. We should have liked to see the question of the magnetic deformation of Röntgen and Lenard rays discussed in connection with the present theory. Why such rays should be produced by an apparatus so different from a Hertzian oscillator as a Crookes' tube, might also well be asked.

The author's familiarity with current research affords sufficient guarantee of his competency to put forward a theory possessing certain points of novelty. We are still so much in the dark as to the nature of Röntgen rays, that every new theory is worthy of the careful consideration of physicists. Without wishing to commit ourselves, the theory of electric waves of very great length strikes us at first sight as being no less plausible than many of the other hypotheses which have been propounded.

A Text-book on Applied Mechanics. By Andrew Jamieson, M.I.C.E., Professor of Electrical Engineering in the Glasgow and West of Scotland Technical College. Vol. ii. Pp. xiii + 388. (London: Charles Griffin and Co., Ltd., 1897.)

This text-book, of which this is the second volume, was written mainly for second and third year students of applied mechanics. Parts i. and ii., which form vol. i., deal with the principle of work and its applications, and gearing; the present volume, divided into Parts iii. to vi., includes motion and energy, graphic statics, strength of materials, and hydraulics.

The volume is divided into fifteen chapters, called lectures, though the ground covered in any one of them is generally much greater than any teacher would attempt in one lecture and numerous illustrative examples are given at the end of each chapter. It is refreshing to find the author introducing the calculus so freely into a text-book primarily intended for science and art students. In Part iii. the author discusses very fully such important practical questions as the energy of fly-wheels, engine governors, and the balancing of moving parts: the whole section is a very complete and good one. The next

section, Part iv., is entitled "Graphic Statics," and is devoted to the graphical determination of the stresses in the bars of framed structures, and to the theory on which these graphical constructions depend. The examples selected are comprehensive, and include most of the ordinary roof and bridge trusses; cranes, sheer legs, &c., are also studied. Bending moment and shear diagrams, which come very much better in Part v., are rather out of place in Lecture xxviii.; it would certainly have been far better, and less confusing to the reader, to have taken them up in the section on strength of materials, which forms Part v. of the book. This section is by no means as complete as the others preceding it. The lectures dealing with the stresses and strains in beams and shafts are full, and well worked out; but tension is treated in a very half-hearted way, while struts and their strains and stresses are simply entirely ignored: this is most unsatisfactory. It is to be hoped that in a new edition Prof. Jamieson will look to this. The omission detracts greatly from the practical value of Part v.

The last Section (vi.) is hardly entitled to the name of hydraulics, and it would have been far better to have omitted it altogether. There are only two chapters: one deals with the hydraulic plant in a modern gas-works; it is, however, almost exclusively descriptive, quite unlike all the rest of the book.

The last chapter is given up to refrigerating machinery; though what this has to do with hydraulics the author does not condescend to explain: it is, in fact, good matter in the wrong place. We confidently recommend the book to engineering students, who will find it of much use in their study of the various branches of practical mechanics touched upon by the author.

H. B.

Twenty-first Annual Report (1896) *of the Department of Geology and Natural Resources, Indiana.* By W. S. Blatchley, State Geologist. Pp. viii + 718. (Indianapolis, 1897.)

THE contents of this volume refer very largely to the economic natural resources of the State of Indiana, and embrace the results of the work accomplished by the different divisions of the Department under Mr. Blatchley's administration during the year 1896. The papers deal with the petroleum industry in the State, composition of Indiana coals, Indiana caves and their fauna, the geology of the middle and upper Silurian rocks of Clark, Jefferson, Ripley, Jennings and Southern Decatur Counties, the oölitic limestone of Indiana, the natural gas of the State, the geology of Vigo County, and the uncultivated ferns and fern allies and the flowering plants of the same county. Several excellent plates illustrate the report, and the whole volume shows that the State, which twenty years ago was noted mainly for her agricultural products, possesses great natural resources, and is rapidly assuming high rank as a mineral producing and manufacturing centre.

The Mines of New South Wales, 1897. Compiled and edited by C. W. Carpenter. Pp. 552 + lxxviii. (Sydney, London, &c.: George Robertson & Co.)

THE vast mineral resources of New South Wales may be judged by reference to this handy volume. The mines—which range from the mines of the Broken Hill Proprietary Company, with 6,512,000*l.* of dividends, to a coal mine worked by its proprietor in his spare time—are in the first place arranged geographically, and, in the case of each, particulars are given—as the proprietors, development, yields, area, &c. In the geological section of the book the mines are arranged under the names of the minerals obtained from them. The remainder of the volume is taken up with descriptions of batteries and ore-reducing works, and lists of directors of mining companies, New South Wales mining patents, and an alphabetical list of mines.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Submerged River-Valleys and Escarpments off the British Coast.

IN connection with the observations of American geologists—especially those of Prof. J. W. Spencer and Mr. Warren Upham—on the "drowned" terraces and cañons of the American coast, the eastern borders of the North Atlantic afford some interesting results when examined with the aid of the Admiralty charts. It has long been known from the researches of the late Mr. Godwin-Austen, Prof. T. Rupert Jones, and others, that the British Isles are planted on a platform, of about 100 fathoms near its margin, and known under the name of "the 100-fathom platform." I am now engaged an a careful study of this physical feature, and the results, though as yet incomplete, are of such interest that I may be permitted to place them briefly before your readers. By tracing the contours, which may be drawn on the chart of the British Isles from the neighbourhood of Rockall as far south as the entrance to the Bay of Biscay by the aid of the very numerous soundings, two well-marked features may be recognised. The margin of the platform is very nearly defined by the 100-fathom line off the coast of Scotland, where it terminates along "the Vidal Bank"; but from this level it gradually falls away southwards, till at the entrance to the Bay of Biscay it reaches the 200-fathom contour; from this margin the floor of the ocean gradually slopes upwards to the coast, so as to constitute a shelving plain with little interruption. West of the coast of Ireland the platform is as broad as Ireland itself; that is, about 200 miles at its greatest breadth; and here it breaks off in a magnificent escarpment of no less than about 1300 fathoms (7800 feet) in height, its base giving place to a second gently sloping plain from 1500 to 2000 fathoms; or 9000 to 12,000 feet in depth, leading down to abyssal regions. This grand escarpment of about 7000 feet in height is continuous with the Vidal Bank, and opposite the English Channel bends sharply round to the eastward; in some degree conforming to the outline of the land. That this escarpment was once an emergent physical feature, corresponding to those of Eastern America, now submerged, or of the now unsubmerged terraces of Colorado, is a deduction of which I am now absolutely convinced, notwithstanding the stupendous physical changes which the deduction involves. We will now proceed to consider briefly some evidence of a corroborative kind, from which I cannot see any possibility of escape; I refer to the existence of river-valleys now traceable across the British platform, and opening out into gorges on approaching the edge of the escarpment. Some of the existing river-courses, like those of the Severn and the Kenmare rivers, are somewhat obscurely indicated by the soundings across the platform; but there are two distinctly traceable river-courses which are now altogether submerged: the first descending from the Irish Channel; the second through the English Channel. Assuming for a moment, what will scarcely be denied, that the platform down to a depth of 100 to 200 fathoms was formerly a land surface, it is clear that the streams entering from the existing lands must have had an outlet by means of rivers entering the Atlantic westwards. The examination of the soundings shows that this drainage was effected by means of two large rivers running near the centre of these channels, receiving the streams from either side. On tracing them across the platform, and on approaching the edge of the escarpment, we find the channels rapidly deepening, and within a mile or two of the edge taking the form of deep and narrow gorges, ultimately broadening out into "embayments," descending down to the very base of the escarpment itself; a condition corresponding to the "base levels of erosion" of the American geologists; and also represented by some of the Scandinavian fjords. Such physical features are altogether terrestrial. It is impossible (as it seems to me) that they could have been originated while the region referred to was in its present condition of ocean-bed. One portion of the river-valley which drained the English Channel is very clearly indicated on the chart under the name of the "Hard Deep." This gorge, about a quarter of a mile broad and seventy miles in length, occupies that narrow part of the channel between Cape de la Hague on the coast of France and the Bill of Portland. Throughout the

course of this old river-valley over the platform the channel has, to a great extent, been choked up and nearly obliterated by the deposit of sediment constantly going on for long ages; but along this part of its course, owing doubtless to the force of the tidal currents due to the narrowness of the channel, the sediment has apparently not been able to accumulate; hence the well-defined banks of rock which the soundings disclose. As regards the submerged channels of the existing rivers entering the Atlantic westwards, only faint indications can be obtained from the soundings; nor is this surprising when we recollect that the North Sea, the Irish Channel, and portions of the ocean bordering the north-western coasts of the British Isles have been covered in part by land ice, and altogether by the muddy waters of the later glacial seas, giving place to those of the present day; the mud, sand and shingle thus deposited have sufficed to cover the old floor of the platform for many feet in depth in most places, and to fill up the channels of the streams formed during earlier emergence. The total distance from north to south through which these observations extend is about 500 miles. I hope to be able to return to the subject later on. EDWARD HULL.

The Use of Compressed Coal Gas.

IT may be of interest to users of the limelight to put on record the following occurrences.

A 40-feet cylinder was filled with coal gas at a pressure of 120 atmospheres by a leading London firm on March 15, 1897; a small quantity was used, and the cylinder stood till October 9. It was then used for a mixed jet, and at the end of half an hour the light began to decrease, and in another quarter of an hour practically no gases were issuing. On relighting the jet the light was found perfect, and the fault was ascribed to the Beard's regulator.

The cylinder was again used on March 5 last, and again after half an hour the light began to fail; but on turning the taps full on something audibly blew out of the nozzle, and the light was perfectly restored.

The lime blackened excessively: while white-hot, the "hydrogen" was turned off and the oxygen allowed to play on it, when the deposit turned a brilliant orange-red.

The coal gas was then passed through a glass tube gently heated in a Bunsen flame—a copious metallic mirror which gave the test for iron was formed.

It seems probable that the jet was choked by the decomposition of iron carbonyl at the high temperature. In any case there is an obvious disadvantage in storing for a considerable time compressed coal gas in steel cylinders, altogether apart from the possible damage to the cylinders, which has been shown to be small. C. E. ASHFORD.

Harrow, March 19.

THE SCIENCE BUILDINGS AT SOUTH KENSINGTON.

SINCE the nation acquired, a good many years ago now, a plot of ground from the Royal Commissioners of the Exhibition of 1851, at a cheap rate, on which to erect buildings to foster teaching and research in Science and Art, there have been many schemes put forward, but nothing done, till at last the teaching of Science has become desperate. The Government have known this fully, and a few years ago plans were designed to bring to a head the various schemes by erecting Science buildings on the west side of Exhibition Road, and the Art buildings on the east side, an allocation of the spare land which had been accepted in principle by everybody.

But now it appears there has been a sudden *volte face.* Seeing that *at the present* moment Art does not require all the space at its disposal on the east side, the interstices are to be filled up with certain of the science buildings as we gather from the statement made by the First Commissioner of Works, on Thursday last: "The Government asked for the large sum of 800,000*l.* for the completion of the buildings at South Kensington in connection with Science and Art. He was quite certain that the Committee would admit that the settlement of this question had been demanded both by the House and by the public for many years past. In 1891 the decision was come to to proceed with the building to complete the accommodation for the Art Museum, and for housing the administrative departments of Science and Art. Plans were accordingly prepared by Mr. Aston Webb, and accepted, for a building to occupy the land on the south side of the Museum facing the Cromwell Road; but the sources at the disposal of Chancellors of the Exchequer, on both sides of the House, unfortunately did not permit of the grant of the necessary funds, and the scheme had since then been in abeyance. Since that scheme was formulated, and partly in consequence of the report of the Commission on Secondary Education, it was in contemplation to move to the Education Office the secretariat of the Science and Art Department, and further—in accordance with the recommendation of the Select Committee of last year on the South Kensington Museum—it was decided to remove the official residences and certain other temporary buildings, which were a source of danger from fire. With this additional space at disposal, it would now be possible to provide on the eastern side of Exhibition Road the necessary accommodation for both Science and Art. It was, therefore, intended to build, in addition to the building proposed in 1891, further buildings which would complete the frontage on the Cromwell Road and Exhibition Road sites; and, in the opinion of the Government, that would amply meet the requirements of both branches for many years to come."

On this proposal the *Times* remarks:—

"How far these projects, which the Government regard as all that can be reasonably demanded, will be satisfactory to those who take more than an official interest in the matter it would be premature to speculate."

We do not think it "premature" to state that it is to be hoped that the Government before they go further in this matter will obtain some opinions from men of science. The suggestion appears little short of disastrous, having regard for the future representation of scientific teaching and illustrations in our National Institutions, for surely the Empire will outlast another century. These remarks are not made because the sum asked is too little, for we do not believe a Committee, say of the Royal Society, or the President and Council of the Society itself, appointed to consider the matter, would see its way to spend more than 250,000*l.* to cope with the present needs of Science.

SKIAGRAPHY AFTER INJECTION OF THE BLOOD VESSELS WITH MERCURY.

TO elucidate the relations of the various opaque structures of the body to one another whilst undisturbed by the processes of dissection, is one of the numerous uses to which skiagraphy has been applied.

It is obvious that this process may be extended to the blood vessels in the dead body by filling them with some medium which is opaque to the X-rays, and in this way their relative situations to each other and to the bony skeleton may be studied with facility. Various experimenters have occupied themselves with the task of producing such skiagraphs, and amongst a considerable number who have obtained successful pictures may be mentioned Dutto, Raw, and Remy and Contremoulins, the former of whom employed a plaster injection mass, the latter one of wax in which bronze powder was suspended.

These results, though sufficiently encouraging, were not wholly satisfactory, and one of us (H. J. S.) determined to follow out a method which he had devised before he became acquainted with the work of other observers, and in which metallic mercury had been selected as the substance to be injected. The results of our experiments with it have been most satisfactory, and it seems probable that with the greater experience which we have now gained in the methods of carrying out the

details of the process, still better work may be done than has yet been accomplished.

The plan which has been adopted is very simple. The blood vessels of the part to be injected are well washed out with a solution of six parts of common salt in a thousand parts of water, and the mercury is then injected by inserting into the principal artery a canula connected with a small reservoir of the metal by a piece of rubber tubing. Care must be exercised to prevent the presence of air in the tubing or canula, and the mercury should be injected at a moderately low pressure, which naturally varies in different cases, but as a general rule may be taken at about 30 to 50 mm. of mercury. If the pressure is excessive there is considerable risk that the resistance which the capillaries offer to its advance will be overcome, and the veins will be filled as well as the arteries. One very important detail is that the injected specimen should be moved as little as possible after the injection has been effected, as any shaking or change of position is apt to cause breaks to occur in the column of mercury, and thus to interfere with the success of the skiagraph.

Fig. 1.—Arteries of head and brain in a child.

We have also found that if the specimen has to be kept for some time before the injection is made, one can preserve it very satisfactorily by filling the blood vessels with a 5 per cent. solution of formalin, which in no way interferes with the subsequent injection, except that it lessens somewhat the calibre of the vessels.

The skiagraphs have been taken in the ordinary way; the authors have employed a 10-inch spark "Apps-Newton" coil, and, as a rule, ordinary focus tubes supplied by Mr. Newton, which they have found very satisfactory. Of the illustrations which accompany this paper, Fig. 1 represents the arterial system of the head of a child. The brain is *in situ* within the cranium, and the whole is injected through the carotid artery in the neck. The very abundant blood supply to the basal ganglionic masses of the brain is well shown, and it is interesting to note the great tortuosity of the internal carotid arteries as they pass through the base of the skull, by which the force of the sudden rise of blood pressure on the advent of the pulse wave is reduced so far as to prevent an undue strain being thrown on the delicate structures within the cranium. In order to prevent the escape of mercury through the several vessels in the neck, the head was placed upside down upon a small beaker, whose shadow appears in the photograph; where large vessels had been severed, clamp forceps were applied.

The other illustration (Fig. 2) shows the result of an injection of the branches of the system of the superior vena cava. The subject in this case was a young child, and the incomplete ossification of the bones, especially near the joints, may be incidentally noted.

In this instance the body was placed lying on its back on the photographic plate, whilst the Röntgen lamp was fixed in front of the chest; and therefore the anterior part of the bony skeleton is rendered indistinct, whilst the vertebral column and posterior portions of the ribs are relatively prominent. The injection has filled the main branches of the superior caval vein and the spinal veins, and it has penetrated also into the right auricle and ventricle, from which it has reached the larger divisions of the pulmonary artery.

It must be remembered, in identifying the various structures in the photograph, that when a print is taken from a negative the relations of the parts are reversed as in a mirror image, and thus what is really on the right-hand side in the specimen appears on the left in the print, and *vice versâ*. This can, when desired, be obviated either by producing the print by the single transfer carbon process, or by taking the original skiagraph with the film side of the negative furthest from the subject. In this case, since glass considerably obstructs the passage of the X-rays, the negative should be on a celluloid support, and the sensitised surface may be laid upon a fluorescent screen. When this is done, the rays after having penetrated the film are still further utilised by inducing fluorescence of the screen, which in its turn acts on the emulsion of the negative. The result of the manœuvre, though somewhat shortening the length of exposure, seems to render the resulting impression rather less sharp in its definition.

A point which must impress any one who looks at these photographs is the extraordinary vascularity of the tissues of the body, and one might reasonably wonder how comparatively small wounds, to say nothing of the large and deep incisions which are required in the course

of many surgical operations, do not inevitably lead to the death of the sufferer by hæmorrhage. The reply to this is, that did the prevention of hæmorrhage depend solely on the efforts of the surgeon, there is little doubt that even small wounds would prove inevitably fatal; but provision has been made by nature to meet the emergency, and the bleeding is largely stopped by what is known as the natural arrest of hæmorrhage.

It is not possible to describe this process in detail in the present paper, but the main elements involved are the fact that blood on escaping from the vessels tends to coagulate, and so forms a plug which prevents further escape, and that the severed vessel retracts up its sheath so that the plug is more efficiently supported, whilst the diameter of the vessel is itself greatly reduced by the contraction of the muscular elements in its walls. By these means the blood flow is temporarily checked, and as the wound gradually heals, secondary changes occur in the cut vessels which lead to their permanent occlusion.

FIG. 2.—Injection of veins in chest.

Another fact that is well illustrated in such skiagrams is the extreme freedom of anastomosis between many of the smaller vessels which arise at different points of the chief arteries. It is this system of anastomosis which permits surgeons to ligature the main artery of a limb without running serious risk of mortification following the operation; as the blood, unable to pass by its ordinary channels, dilates the smaller vessels which bridge the occlusion, and thus establish an efficient collateral circulation in the course of a brief period after the ligature has been applied.

H. J. STILES.
H. RAINY.

SIR HENRY BESSEMER, F.R.S.

THE death of Sir Henry Bessemer, announced last week as we went to press, removes a leading representative of the world of applied science, and one whose inventions revolutionised a manufacturing process.

Henry Bessemer was born in 1813 at Charlton, in Herts, and was thus eighty-five years of age at the time of his death. From his father, who was an artist and a member of the French Academy of Sciences, he seemed to have inherited certain artistic tendencies, for at an early age he showed a fondness for modelling and designing patterns. He soon, however, turned his attention to other matters, and began the long series of inventions which carried him on to fortune. His success commenced with the invention of a means of manufacturing bronze powder or "gold" paint from Dutch metal. This invention laid the foundation of his fortune, and it was the profits of the manufacture of the bronze powder which enabled him to carry on experiments in the metallurgical process which bears his name.

Bessemer's first experiments to improve the quality of iron were made in 1855. He was not an iron manufacturer when he began his work, neither was he a metallurgist. But he possessed the true instincts of an investigator, for he was quick to observe and sound in his deductions; and the man who possesses and utilises these qualities is a man of science, whether he has had a systematic training in theoretical principles or not. His own account of the observations and reasoning which led to the idea of the Bessemer process is interesting. While making experiments with iron in the open-hearth furnace, the following incident occurred:—

"Some pieces of pig iron in one side of the bath attracted my attention by remaining unmelted despite the great heat of the furnace, and I turned on a little more air through the fire-bridge with the intention of increasing the combustion; on again opening the furnace door after an interval of half an hour, these two pieces of pig still remained unfused. I then took an iron bar with the intention of pushing them into the bath, when I discovered that they were merely thin shells of decarbonised iron, thus showing that atmospheric air alone was capable of wholly decarbonising grey pig iron, and converting it into malleable iron without puddling or other manipulation. It was this which gave a new turn to my thoughts, and after due consideration I became convinced that if air could be brought into contact with a sufficiently extensive surface of molten crude iron the latter could rapidly be converted into malleable iron."

On August 13, 1856, Bessemer read a paper at the Cheltenham meeting of the British Association, entitled "The Manufacture of Malleable Iron and Steel without Fuel," this being the first account that appeared shadowing forth the important manufacture since known as the Bessemer process. The paper, however, was not printed in the Association's Report for 1856, and the title, where mentioned, it may be noted, is quoted without the word "malleable." It was followed, in 1865, by a long communication, read at the Birmingham meeting, "On the Manufacture of Cast Steel; its Progress and Employment as a Substitute for Wrought Iron." Sir W. (now Lord) Armstrong, the President of the Section, in referring to it, remarked as follows:—"The paper from Mr. Bessemer upon steel cannot fail to be highly valued by the Section. The growing importance of this material, and its rapidly extending sphere of usefulness, have attracted attention in a special degree to the question of economy in its production; and certainly no one has contributed so largely as Mr. Bessemer to our advance in this direction."

The first honorary recognition of the importance of the Bessemer process in this country was made by the Institution of Civil Engineers in 1859 by the award of the Telford medal. In 1871–73 he was President of the Iron and Steel Institute, and in 1872 he received the Albert medal of the Society of Arts "for the eminent services rendered by him to Arts, Manufacture, and Commerce, in developing the manufacture of steel."

In 1874 he was a member of a Committee appointed to

consider what steps could be taken in furtherance of the use of steel for structural purposes, and signed the report, which was issued in March 1877. He was elected a Fellow of the Royal Society June 12, 1879. His certificate of claim is probably as short as any ever set forth for candidature, bearing, as it does, the single sentence, "Discoverer of the Bessemer process of making steel." In the same year he received the honour of knighthood, and in 1880 was presented with the freedom of the City of London. From abroad he received many honours. He was offered the Grand Cross of the Legion of Honour; but as permission to wear it was refused, he had to be content with a large gold medal given him by Napoleon III. He was an honorary member of the Iron and Steel Board of Sweden, a freeman of the City of Hamburg, an honorary member and gold medallist of the Society of Arts and Manufactures of Berlin, and a Grand Cross of the Order of H.I.M. Francis Joseph of Austria.

His written contributions to science were very limited. The Royal Society's "Catalogue of Scientific Papers" contains one other besides the two already given, viz. "On the Resistance of the Atmosphere to Railway Trains and on a means of lessening the same" (*Franklin Inst. Journ.*, vol. xiv., 1847). It is in connection with his metallurgical labours that his name will go down to posterity; and as an inventor who refused to be discouraged by obstacles, and pertinaciously held on to a scheme until it carried him to success.

NOTES.

A special meeting of the Royal Society will be held in the rooms of the Society at Burlington House on Thursday, March 31, at 4.30 p.m., to receive preliminary statements as to the results of observations made during the recent total solar eclipse. Communications will be made by the Astronomer Royal, Sir Norman Lockyer, K.C.B., and other gentlemen.

Mr. Chree's communication in another column relating to the present disturbed magnetic conditions is most interesting in relation to the recent eclipse. The remarkable association of a great number of sun-spots was connected in the telegrams from Viziadurg with the brightness of the corona, and the absence of the equatorial extensions seen at the period of minimum sun-spots. The wonderful chemistry of the spots may also be referred to recent observations indicating chiefly the presence of scandium and vanadium. Magnetic storms and auroræ therefore are little to be wondered at. Were there any indications in January and February?

At the meeting of the British Association held at Toronto last year, a resolution was passed by the general committee, requesting the Council to consider the desirability of approaching the Government with a view to the establishment in Britain of experimental agricultural stations similar in character to those which are producing such satisfactory results in Canada and elsewhere. This proposal was referred by the Council to a special committee, which has since made a report. The committee, while agreeing that some central institution might be of great use in the improvement of agriculture in this country, pointed out that there are already a number of independent bodies, connected with agricultural societies, colleges, and county councils, which are conducting agricultural investigations, and that it would be undesirable to approach the Government without the co-operation and support of these various bodies. The Council of the British Association has accepted this report, and has requested the committee to communicate with the various institutions interested in agriculture throughout the country, and to ascertain their views upon the subject. We are informed that the committee are now in communication with the various institutions referred to, in order to obtain a combined opinion upon the desirability of the creation by the Government of a central agricultural institution, for the purpose of undertaking agricultural research, and of acting as a centre of union for the various bodies conducting similar researches in this country, and of affording them advice and assistance when desired.

The following officers of sections have been appointed for the Bristol meeting of the British Association:—Section A—President: Prof. W. E. Ayrton, F.R.S. Vice-Presidents: Prof. Rücker, F.R.S., Prof. S. P. Thompson, F.R.S. Secretaries: Prof. A. P. Chattock, Prof. W. H. Heaton (Recorder), J. L. Howard, W. Watson, E. T. Whittaker. Section B—President: Prof. F. R. Japp, F.R.S. Vice-President: Prof. W. Ramsay, F.R.S. Secretaries: Dr. C. A. Kohn (Recorder), Dr. T. K. Rose, F. Wallis Stoddart. Section C—President: W. H. Hudleston, F.R.S. Vice-President: E. Wethered. Secretaries: G. W. Lamplugh, Prof. H. A. Miers, F.R.S. (Recorder), E. Wilson. Section D—President: Prof. W. F. R. Weldon, F.R.S. Vice-Presidents: Prof. F. Gotch, F.R.S., Prof. L. C. Miall, F.R.S. Secretaries: W. Garstang, Dr. A. J. Harrison, W. E. Hoyle (Recorder). Section E—Vice-Presidents: Colonel F. Bailey, Dr. J. Scott Keltie. Secretaries: H. N. Dickson, Dr. H. R. Mill (Recorder), A. J. Herbertson, H. C. Trapnell. Section F—President: Dr. J. Bonar. Vice-President: Prof. E. C. K. Gonner. Secretaries: E. Cannan, Prof. A. W. Flux, H. Higgs (Recorder), W. E. Tanner. Section G—President: Sir John Wolfe-Barry, F.R.S. Vice-President: G. F. Deacon. Secretaries: Prof. T. H. Beare (Recorder), H. W. Pearson, W. A. Price, Prof. John Munro. Section H—President: E. W. Brabrook, C.B. Vice-President: C. H. Read. Secretaries: H. Balfour, J. L. Myres (Recorder), Dr. G. Parker. Section K—President: Prof. F. O. Bower, F.R.S. Vice-President: Prof. H. Marshall Ward, F.R.S. Secretaries: A. C. Seward (Recorder), Prof. J. B. Farmer, J. W. White.

Sir George King has retired from the superintendentship of the Royal Botanical Gardens, Calcutta, and has been succeeded by Surgeon-Major David Prain.

The Bakerian Lecture will be delivered at the Royal Society this afternoon by Dr. W. J. Russell, F.R.S., the subject being "Further experiments on the action exerted by certain metals and other bodies on a photographic plate."

The centenary of the discovery of the voltaic pile will shortly be celebrated at Volta's birthplace on Lake Como.

M. Émile Picard, member of the Paris Academy of Sciences, and professor of higher algebra in the University of Paris, has been elected corresponding member of the Berlin Academy of Sciences.

Dr. Ludwig Mond, F.R.S., has been elected a member or the Athenæum Club, under the rule which empowers the Committee to elect annually nine persons "of distinguished eminence in science, literature, the arts, or for public services."

The annual meeting of the Iron and Steel Institute of Great Britain will be held in London on Thursday and Friday, May 5 and 6. At this meeting the Council will present their annual report for 1897, and a number of papers will be read and discussed. The autumn meeting of the Institute will be held at Stockholm, under the auspices of the Swedish Association of Ironmasters, on Friday and Saturday, August 26 and 27.

The Academy of Mathematical and Physical Sciences of Naples offers a prize of 500 lire for the best memoir on some subject connected with stereo-chemistry. The essays, which must be in Italian, Latin or French, must be sent in to the Secretary of the Academy not later than June 30, 1899. A prize of 1000 lire has just been awarded by the Academy to Prof. Giuseppe de Lorenzo for his essay on the pleistocene lakes of Southern Italy.

THE Royal Academy of Sciences of Bologna announces that a gold medal in memory of Aldini will be awarded in 1899 for the best essay on galvanism (animal electricity). The essays may be either in Italian, French or Latin, or may be in any other language, provided the author sends in a translation in one of these languages. They may either be in manuscript or printed, provided that in the latter case their publication has taken place within the two years preceding the award. Papers competing for the prize are to be sent before May 29, 1899, addressed to the Secretary of the Royal Academy of Sciences of the Institute of Bologna.

PROF. B. BRAUNER, of Prague, addressed an extraordinary meeting of the Chemical and Physical Society of University College, London, on Friday, March 18, and gave an account of his investigations with regard to the elements thorium, praseodymium and neodymium, his revision of the atomic weights of the latter elements, and their probable positions in the periodic table. In concluding his address, Prof. Brauner drew attention to the scientific importance of further investigation among the rare earths, and expressed a hope that more chemists would enter this field of research, which promised results of the highest value. In proposing a vote of thanks, Prof. Ramsay pointed out that the work, of which an account had been given, was a monument of careful experiment and extraordinary industry. Although it might appear to many present that an enormous amount of labour had been expended on an obscure corner of chemistry, it must be remembered that it was precisely such work which bore on the whole of chemical theory; and, indeed, which might be expected to influence chemical manufactures at a future date. It was possible that in the middle of the next century these researches of Prof. Brauner might bear fruit in extensive industrial application, and that these researches might become household words in the mouths of future generations of chemists. Prof. Tilden, in seconding the vote of thanks, desired in the first place to offer to the Society his own thanks, and those of his colleagues and students who were present, for the courteous invitation which had been extended to them. He congratulated Prof. Brauner on the success which so far had attended his labours, to which he had brought so large a supply of patience and perseverance, and in framing his hypotheses so much of the inspiration of the poet. In regard to the origin of these strange elements, the choice seemed to lie between the notion that they represented the ruins of a former state of things, or they might stand for those "old worn particles" referred to by Descartes, and on the other hand the idea that they resulted from the condensation of the original protyl, though in some way the process differed from that which gave rise to the rest of the elements. With regard to cobalt and nickel, which had been mentioned, he thought it probable that their atomic weights would ultimately turn out to be not quite so nearly identical as sometimes supposed. At the close of the meeting Prof. Brauner exhibited the absorption spectra of salts of praseodymium and neodymium, and a number of specimens of the pure salts.

AT a meeting of the Associated Chamber of Commerce, on March 17, Sir H. Stafford Northcote, Bart., M.P., in the chair, the following resolution was carried unanimously:—"That, in the opinion of this Association, the compulsory adoption within some limited period of the metric system of weights and measures legalised by the Act of last Session be advocated by every possible means, with the view of inducing Her Majesty's Government to afford facilities for the amendment of the law in this respect, and that a copy of this resolution be sent to the President of the Board of Trade and to the First Lord of the Treasury. This Association urges the Government meanwhile to adopt the metric system of weights and measures, as far as possible, in all Government contracts and returns, so as to make it familiar to the people; and recommends individual Chambers of Commerce to press the matter upon the attention of local governing bodies, to the end that these also may employ the system in all public contracts, and thus facilitate its general adoption."

WORK has just been begun upon a new building—the Horniman Free Museum—which Mr. F. J. Horniman, M.P., intends to present to the inhabitants of Dulwich and the neighbourhood. Several years ago Mr. Horniman filled a house at Forest Hill, London, with curios and objects of natural history, and made this museum free to the public. He now proposes to house the collections more elaborately, and it is for this purpose that the new building is to be erected. The building will contain two lofty galleries, each 100 feet long, lighted from the top. In addition, there will be a large lecture theatre capable of seating 300 people. The galleries will be divided into various courts, each devoted to a separate class of objects. Special provision will be made for the zoological and entomological specimens. Around the site of the new museum Mr. Horniman has purchased fifteen acres of ground, which he intends to convert into a public park and recreation ground. One of the mansions at present occuping the site is to be fitted up as a free library and club house, separate rooms being devoted to the free use of the scientific and other clubs in the neighbourhood.

THE *Athenæum* announces that the Accademia dei Lincei has chosen Prof. Eugenio Beltrami as president, in place of the late Prof. Brioschi. The new president of the most important scientific society in Italy, like his predecessor, is a mathematician. He is a native of Cremona, sixty-three years old, and has enriched his special branch of literature with a series of works on differential geometry, electricity, and magnetism. He is at present occupied with the editing of Leonardo da Vinci's "Codice Atlantico."

SOME few years ago the attention of readers of NATURE was directed to the then very remarkable utterance of an Oxford theological tutor on the subject of evolution. We refer to the late Canon Aubrey Moore. We now quote a striking passage by another Oxford teacher, whose sincerity and philosophic acumen are becoming generally recognised—the Rev. Charles Gore, Fellow of Trinity College, Oxford, and Canon of Westminster. The lecturer, after referring to the extraordinarily free way in which St. Paul quotes the Old Testament, says that: "Thereby we learn a lesson which we have got to learn, that Divine revelation does not include critical methods. God leaves us to the critical methods natural to every age, and each age must readjust its criticism. What God does give us is a moral and spiritual revelation of His own being and of our being, of our destiny and of our sin, and a revelation of the Divine means that God has taken for our recovery; and we have got to learn that lesson. Divine revelation is in the things of faith and morals—as we say, is of spiritual things; and we only bewilder our intelligences and cause stumbling-blocks if we try to assert that Divine revelation is given of these matters of natural science which progress from age to age by human investigation." The passage is quoted from a verbatim report in the *Guardian*, as it was delivered in Westminster Abbey to a crowded audience of thoughtful men on March 11, during Canon Gore's third Lent lecture on the epistle to the Romans.

IN *Annalen der Hydrographie und maritimen Meteorologie* for February, Dr. W. J. van Bebber has an article on weather prediction, with especial reference to the storm signal service on the German coasts. The author lays stress upon the difficulty of obtaining a clear idea of the success of weather predictions in different countries owing to the various methods of checking them, and thinks that the only safe criterion is the opinion of the public most interested in them. He makes various proposals

for the improvement of the forecast, most of which have been previously considered, *e.g.* : (1) The extension of telegraphic communication to islands in the North Atlantic. (2) The introduction of the so-called circular system of communication, by placing the principal stations and central offices throughout Europe in direct telegraphic correspondence with each other, immediately after the observations are taken. (3) More frequent telegrams, and where possible the establishment of telemeteorographs, or instruments reporting the chief meteorological elements continuously to the central offices. This arrangement already exists at a few places on the continent. (4) A direct exchange of telegrams between various signal stations. (5) The adoption of means for more generally disseminating the principles of weather conditions among the public, and the publication of an atlas containing types of weather, by means of which telegraphic reference to conditions similar to those actually existing might be made, without waiting for the publication of weather charts, as at present. The serious question of expense underlies the adoption of any of these suggestions.

THE Industrial Commission, appointed by the Lieutenant-Governor of the Isle of Man, to consider the best means of promoting new Manx industries, received from Prof. Herdman, at a meeting held last week, some important evidence relative to encouraging Manx sea fisheries, spawning beds, and hatcheries. Prof. Herdman expressed the opinion that the failure of the herring fisheries was more due to natural causes, such as the absence of food or changed meteorological conditions, than to overfishing or other cause that could be controlled. He did not think that fish were scared away, because the herring was a most tenacious fish, and would go where it wanted in spite of great difficulties. He did not think that steam trawlers did much harm by destroying spawn. On the contrary, they rather did good by catching the fish (haddock) that lived on herring spawn. He agreed that the three-mile limit was a good rough and ready method of preserving young fish. To obtain any other method of protection would require international law. With regard to hatcheries, he favoured the establishment of hatcheries for cod, plaice, and white sole at Port Erin, and oyster beds at Derbyhaven.

AN interesting report has been made to the Essex Technical Instruction Committee by Mr. T. S. Dymond, the Staff Lecturer on Chemistry, on the damage done to the land by the salt-water flood due to the injury of the sea-banks by the gale and high tide of November last. From this report it appears that round the coast of Essex alone about 50,000 acres of land were flooded by the overflowing of the salt water. Upon some of the farms the water only remained a few hours; other land was flooded for six or eight days; and in some cases the sea walls have not been repaired, and the water flows over the land during spring tides. This land in its ordinary condition contains only ·01 per cent. of salt, whereas the flooded land is found by analysis to contain ·20 per cent., equal to two tons an acre in the top six inches of soil. This excess of salt is injurious to vegetation. Peas and tares have suffered severely, wheat has been damaged to a less extent, and where the seed had not germinated does not seem to have been affected. The most serious and more permanent effect, however, is due to the effect of the salt on the earthworms, which after the flood were found strewn upon the surface of the ground, whence they were carried off by the gulls. The use of worms in assisting the drainage and promoting aeration of the soil is universally recognised, and their extermination in the heavy flooded land is therefore a serious matter. The sea salt also, owing to its power of absorbing moisture, renders the soil moist and difficult to work, and also prevents the aeration which is necessary to the roots of the plants, and for promoting fermentation of humus, and nitrification. The injury to the land by the destruction of the earthworms was a fact generally accepted as correct in the inundation due to an exceptionally high tide which covered a large area of the Lincolnshire Fens with salt water at the beginning of the present century.

A SPECIMEN copy of a new French scientific journal has been sent to us, entitled *Archives de Parasitologie*. As its name implies, it is hoped it may become the organ of researches dealing with parasites capable of provoking disease in both man and animals. The editor is Raphael Blanchard, Professor at the Faculty of Medicine of Paris, and he hopes by admitting memoirs in German, English, Spanish and Italian, to encourage foreigners to send their work for publication in his journal. It will appear quarterly, and no pains, it is stated, will be spared to ensure the printing and illustrations being of the best possible character. In connection with the subject of parasitic disease, there is an interesting little article—"Notes on the life-history and microscopic appearances of the parasite of Malaria," by A. E. Griffin—in the current number of the *Middlesex Hospital Journal*. Although the parasite of malaria was discovered and described by Laveran as long ago as the year 1880, its life-history has by no means been yet thoroughly worked out. It is, however, supposed that mosquitos may play an important part in the evolution of this parasite, and that, present as an encysted form in the eggs of these insects, the germs may be introduced through the medium of air or water into the human body; or a mosquito which has become infected with the blood of a malarial patient may attack and infect a human being directly. The medium of infection is generally supposed to be through the air; but there is strong evidence that water may also convey the disease, and Mr. Griffin cites cases of malaria contracted on a ship which, touching at Colombo, took in water there, and twelve days later, the usual incubation period, the disease manifested itself on board. Arsenic in large doses, it appears, proved a more valuable remedy than quinine in the late Ashanti war.

DR. F. VON KERNER contributes a paper on the geography of the middle course of the river Kerka to the *Mittheilungen* of the Vienna Geographical Society. The Kerka ceases to be navigable at the falls of Scardona, and above that point its course is impeded by many falls and rapids. Dr. Kerner's paper is illustrated by six excellent photographs of this picturesque region.

THE third of the *Münchener geographische Studien*, edited by Herr Siegmund Günther, consists of a paper on the structure and distribution of earth pyramids and pillars, by Dr. Christian Kittler. The nature of the deposits in which these structures are formed, and of the erosive action which produces them, is discussed in detail. A noteworthy point is the conclusion that the crowning stone is by no means an essential feature.

DR. GIOVANNI DE AGOSTINI publishes in the *Bollettino* of the Italian Geographical Society a preliminary note on some results of exploration of the lakes of the Roman province. Soundings and temperature observations at various depths, made during 1896 and 1897 in the lakes Bolsena, Mezzano, Vico, Monterosi, Bracciano, Martignano, Albano, and Nemi, are discussed, and contour maps are appended.

AT the meeting of the Vienna Academy of Sciences on February 10, the President read a letter from Prof. J. Luksch, of the *Pola* expedition, dated from Suakim on January 23. On January 10 the *Pola* anchored at Ras Tarfu, and a boat was sent to Geishan to obtain a pilot for El Wasm and Kunfida. Next day a party was landed to make observations, but the observers were attacked by Bedouins, and only escaped after some sharp fighting under cover of the guns of the ship. Fortunately there was no loss in killed or wounded; even the instruments were

brought off safely. Since leaving Mocha, the *Pola* has made valuable observations, chiefly geological, at a number of points along the coast, and amongst the islands.

AN instance of the service which the Department of Scientific and Technical Research of the Imperial Institute is able to render appears in the number of the *British Central Africa Gazette*, which has just reached this country. A specimen of limestone found on Kilwa Island, Lake Shirwa, was sent to the Institute for an opinion as to its value, and Mr. Wyndham R. Dunstan sent the following report upon it:—"The sample of limestone from Kilwa Island, which is used at Zomba for making lime, turns out to be calcium carbonate—Iceland spar. It contains small quantities of iron and magnesium, and also of phosphate. This last constituent, though minute (0·1 per cent.), should be borne in mind in connection with the possible use of the mineral, either burnt or in its natural state, as a manure. Another point, to which I think it would be well to direct attention, is the value of large, well-formed, colourless *transparent*, rhombohedral masses of the spar. These are employed in the construction of certain optical instruments, and I was informed by one of the principal manufacturers not long ago that the supply of these crystals is now very scarce." The *Gazette* states that, on receipt of this information, the Acting Commissioner took steps to procure and send home for valuation transparent specimens of this crystal.

IN a presidential address to the Conchological Society, published in the January number of the *Journal of Conchology*, Prof. Hickson offers a suggestion to explain the untwisting of the body which has admittedly taken place in certain groups of Gastropod Mollusca. The asymmetry of the Gastropod body was clearly brought about by the acquisition of a spire-like shell, into which its possessor could completely withdraw. Such a shell, however, though advantageous as a protection, is an obstacle to locomotion; therefore, if the Gastropod body could be protected in another way, the *raison d'être* for a spiral shell would disappear. Any increase in the size of the foot, bringing about increased powers of locomotion, would be an advantage to the species in giving it a wider range; and, to obviate the disadvantage of exposing the body to the possible attacks of enemies, an obnoxious or poisonous fluid might be secreted. In support of this view, Prof. Hickson states that among Opisthobranchs there is actually a series of forms showing a gradual diminution in the twist of the shell and a corresponding increase in the size of the foot; and, in addition, points out that some Nudibranchs have been shown to be distasteful to fishes.

IN *Bulletin* 11, new series, of the U.S. Department of Agriculture (Division of Entomology), Mr. L. O. Howard describes the introduction and spread of the Gipsy Moth (*Porthetria dispar, L.*) in Massachusetts, and the means employed for its extermination. This species, injurious on the Continent, but now apparently extinct in Great Britain, was introduced into Massachusetts in 1869 by the escape of examples imported for experiments in silk-growing. Becoming acclimatised in scrub-undergrowth, it multiplied slowly in spite of efforts made to check it, becoming a serious pest by 1889. Since that time its range has extended to about 220 square miles, within which area it has done enormous destruction by the defoliation of deciduous trees. The State has fought it energetically, expending in the the last eight years as much as 725,000 dollars, in addition to 40,000 dollars allowed by Congress. In some years, however, the grants have been made too late to allow the work of destruction to be adequately proceeded with. The chief measures relied on are spraying the foliage with lead arsenate, destruction of the eggs with creosote, grease-banding the trunks to prevent caterpillar ascent, or tying them round with strips of coarse canvas (burlap), under which the caterpillars assemble, and whence they can be collected. Mr. Howard, who claims that this will rank as "one of the great experiments in economic entomology in the history of the world," estimates that more than nine tenths of the colonies, large and small, existing in 1891, have been exterminated; and, except for the difficulty of dealing with woodlands, there appears to be no reason why continuance of the present treatment should not ultimately achieve the total extirpation of the insect.

PROF. PUTNAM has called our attention to an error in the summary of his paper on the magnetic survey of Greenland (NATURE, February 10, p. 347). He points out that the balancing ring employed was of appreciable width, and that, therefore, the formula used in computing the moment of inertia was correct. In this Prof. Putnam is quite right, and the writer of the notice regrets that he did not follow the description of the instrument with sufficient care. As stated in the article, the numerical results are in no way affected.

A NEW periodical—*The Wide World Magazine*—has just been commenced by Messrs. Geo. Newnes, Ltd. The first number contains several instructive articles, all of which are illustrated by striking photographs. Probably no more remarkable collection of pictures have ever appeared than are reproduced in this new magazine. Among the contents we notice a number of pictures of scenes and people in New Guinea, contributed by Prof. A. C. Haddon; photographs of various devotees; an article by Dr. Nansen, entitled "How the North Pole will be reached"; a number of interesting photographs of scenes in China, by Mr. J. Thomson; reproductions of several of Mr. Saville-Kent's curious photographs; and some memories of Navarino, by Admiral Sir Erasmus Ommanney. The magazine is distinctly in advance of the general type of popular periodical, and its contents bear out its motto that "Truth is stranger than fiction."

THE additions to the Zoological Society's Gardens during the past week include a Mexican Deer (*Cariacus mexicanus*, ♂), a Reddish Brocket (*Cariacus rufinus*, ♂), a Globose Curassow (*Crax globicera*, ♀) from British Honduras, presented by H.E. Colonel Wilson, C.M.G.; two Zebus (*Bos indicus*, ♂ ♀) from India, presented by Commander George Stevenson; a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Mr. M. Lyons; a Senegal Parrot (*Pæocephalus senegalus*) from West Africa, presented by Miss L. Firmin, a Common Fox (*Canis vulpes*, ♂), British, presented by Miss Heard; a Malayan Paradoxure (*Paradoxurus hermaphroditus*) from Singapore, a Hairy Armadillo (*Dasypus villosus*) from La Plata, a Grand Eclectus (*Eclectus roratus*) from Moluccas, deposited; a Manchurian Crane (*Grus japonensis*), four Gold Pheasants (*Thaumalea picta*, ♂ ♂ ♀ ♀) from China, two Argus Pheasants (*Argus giganteus*, ♂ ♀) from Malacca, two Horned Tragopans (*Ceriornis satyra*, ♂ ♀) from South-east Himalayas, two Lineated Pheasants (*Euplocamus lineatus*) from Tenasserim, two Somali Ostriches (*Struthio molybdophanes*, ♂ ♀) from Somali-land, two Many-coloured Parrakeets (*Psephotus multicolor*), four Spotted-sided Finches (*Amadina lathami*) from Australia, a Snow Bunting (*Plectrophanes nivalis*), European; two Lapwings (*Vanellus cristatus*), British, purchased; seven Baer's Ducks (*Fuligula baeri*) from India, received in exchange.

OUR ASTRONOMICAL COLUMN.

MAGNITUDES OF 1081 SOUTHERN STARS.—During a voyage to Australia (1885-86), round the Cape of Good Hope and back by the Red Sea, including a stay of two months in Australia, Mr. Stanley Williams was able to make a very useful catalogue of 1081 stars lying between 30° south declination and the South Pole.

This catalogue has recently been published, so a few words about the method employed in making the observations may be opportune. Before setting out on this journey Mr. Stanley Williams made several hundreds of observations to make himself familiar with this class of work, so that his estimations have considerable weight. He adopted the usual method of making variable star observations by using an opera-glass, and bringing each star and its comparison stars into the centre of the field consecutively. The star undergoing comparison was usually compared with two others of known magnitude, one of which was brighter and the other dimmer than the star to be observed. Instead, however, of estimating the difference of brightness between the comparison star and the star under examination in steps or grades, the magnitude of a step being usually different for nearly every observer, he employed another method. This was to mentally divide the interval between the two comparison stars into as many parts as there were tenths of a magnitude between them, the adopted magnitudes of the comparison stars being, of course, known, and then estimate how many of these tenths the star under observation was dimmer and brighter than the comparison stars.

A step in this case thus corresponded to a tenth of a magnitude on the scale of the "Harvard Photometry." A comparison of the resulting magnitudes of some of the stars observed, which have also appeared in the "Southern Meridian Photometry," shows that "the present catalogue, on the whole, accords exactly with the 'Harvard Photometry,' though the number of stars is too small for absolute certainty." A similar comparison with the "Uranometria Argentina" shows more considerable differences, excepting between 2·8 and 3·4 magnitudes; but it must be remembered that the scale of the "Uranometria Argentina" differs largely from that of the "Harvard Photometry."

In the course of this work one variable, V Puppis, was discovered, and thirteen other stars were found to be probably variable.

THE VARIABLES S CASSIOPEIÆ AND S URSÆ MAJORIS.—Some time ago, in this column (December 2, 1897, p. 105), we had the pleasure of saying a few words about the variable stars S Cephei and T Ursæ Majoris, which Mr. Peek, of the Rousdon Observatory, had so energetically observed and recorded during the years 1887 to 1896. We are now able to refer our readers to another small, valuable pamphlet (No. 3) containing the observations, extending over the same years, of the two variable stars S Cassiopeiæ and S Ursæ Majoris. Each of the observations here recorded is the mean of five visual comparisons with stars whose magnitudes have been previously determined either by Mr. Peek himself or some other observer. Further, the comparisons are all made with stars in the same field of view as the variable under observation, the instrument employed being a 6·4-inch equatorial refractor by Merz. The observations are recorded in a uniform way throughout, in which the date of observation, the magnitude, and remarks as to colour and magnifying power used are given. As in the previous publication, Mr. Peek adds a graphical study of the light changes of these stars throughout each year, and a perusal of these curves is of great interest. We hope Mr. Peek has some more observations of other variables which he will publish in like manner, as it is just such observations that will throw light on the changes which these stars undergo.

OCCULTATIONS PHOTOGRAPHICALLY OBSERVED.—Prof. E. C. Pickering records, in a Circular (No. 26) of the *Harvard College Observatory*, the result of the occultation of 26 Arietis as observed photographically at that observatory. The instrument used was an improved form of that constructed for photographing the eclipses of Jupiter's satellites, and previously described. The phenomenon of this occultation was satisfactorily photographed by Mr. Edward S. King on February 25 of this year. The apparatus was connected with a standard clock, and the photographic plate was moved about 0·03 cm. every time the circuit was closed or opened, two images alternately faint and bright being obtained every second, the duration of exposures being 0·06 and 0·94 seconds. An examination of the series of images showed that the time of occultation could be fixed to within one-tenth of a second. Prof. Pickering adds that by using shorter exposures the uncertainty of the time of disappearance can be still further greatly reduced, especially in the case of brighter stars. 26 Arietis is a star of magnitude 6·1; since satisfactory images were produced in 0·06 seconds, stars probably down to the ninth magnitude can be thus photographically observed. The stellar images were further examined to inquire whether any lunar atmosphere could be detected by noting any change in the intensity of these images; but none was discovered. *A propos* of occultations, it is interesting to draw attention to the fact that Prof. G. P. Bond, more than forty years ago, took a number of photographs of the moon and α Virginis shortly before the occultation of the latter, to determine photographically the position of the moon.

COMET PERRINE.—A telegram from Kiel, dated March 21, informs us that the position of Perrine's Comet at 19h. 7m. Mount Hamilton mean time was R.A. 21h 16m., and Declination 26° 44′ north, the movement in these two coordinates being 14 and 37 seconds respectively.

A MAGNETIC STORM.

SINCE August 1894 no magnetic storm has occurred in England at all equal to one experienced during the last few days. Its first indication at Kew Observatory occurred about 8.55 p.m. on the 14th, when a noticeable increase took place in the horizontal force. This element then oscillated about its normal value to a moderate extent until 4 p.m. on the 15th, when there commenced a large decrease superposed on large oscillatory movements. The minimum was reached about 10.48 p.m. on the 15th. During the subsequent rise, which was very rapid at first, there were some further large oscillations, and the element remained somewhat disturbed until 5 p.m. on the 16th. The vertical force was only slightly disturbed until 2 p.m. on the 15th. After increasing to a maximum about 5 p.m. it decreased rapidly with large oscillations, attaining a minimum about 10.48 p.m. It then reapproached its normal value, the oscillations being large at first, but becoming small early in the morning of the 16th.

The declination disturbance commenced at the same time as that of the horizontal force, but was small until midnight on the 14th. After a general easterly movement, lasting for some hours, the needle reversed its direction, attaining its extreme westerly position about 2·48 p.m. on the 15th. It then recommenced a very conspicuous movement to the east, with various large oscillations. After attaining an extreme easterly position about 11.18 p.m. on the 15th, the needle moved once more to the west, the motion remaining oscillatory. The disturbance did not disappear until about 5 p.m. on the 16th.

The extreme amplitude of the disturbance was: horizontal force, ·0050 C.G.S. units; vertical force, ·0057 C.G.S. units; declination, 1° 26′. In eight minutes, from 10.40 to 10.48 p.m. on the 15th, the horizontal and vertical components exhibited falls of ·002 and ·003 C.G.S. units respectively. The most rapid change of declination occurred some thirty minutes later. Speaking generally, the most salient features were the large falls in both the horizontal and vertical components, and the movement of the declination needle to nearly 1° east of its normal position. The storm was presumably associated with the brilliant aurora visible on the night of the 15th in the northern half of the kingdom and in Denmark (*Daily Weather Report*, March 16).

CHARLES CHREE.

THE AUSTRALASIAN ASSOCIATION.

THE meeting of the Australasian Association for the Advancement of Science, held at Sydney in the beginning of January, appears to have been a very successful one. From the reports which came to hand a few days ago it appears that the meeting was attended by the foremost men of science in the various Australasian Colonies, and that a large number of papers were read in the different sections. The Association now numbers more than six hundred members.

The meeting was opened on Friday, January 6, and on the evening of that day Prof. Liversidge delivered his address as president of the Association. Saturday, January 7, and succeeding days in the following week were largely taken up with the sectional meetings. Papers were read in connection with astronomy, mathematics and physics; chemistry, geology and mineralogy, biology, geography, ethnology and anthropology, economic science and agriculture, engineering and architecture,

sanitary science and hygiene, mental science and education. Reports of some of these papers appeared in the *Sydney Daily Telegraph*, and from a large number of cuttings which Prof. Liversidge has sent us the following abstracts have been obtained.

PRESIDENT'S ADDRESS.

Prof. A. Liversidge, F.R.S., the Secretary and newly-elected President of the Association, delivered an inaugural address on the evening of January 6. The address was a survey of the objects and work of the Association, and a brief statement of the more important questions with which chemists have lately been concerned. The work of the International Catalogue of Scientific Literature was referred to, and the hope was expressed that Australasia would do something to assist the cataloguing of scientific publications. Reference was made to the fact that the Imperial Institute in London was becoming an institution for the advancement of science. It was now fulfilling its intended objects, and was becoming a most valuable means of disseminating a knowledge of the products and manufactures of the Indian Empire and the Colonies; not only of a commercial, but of a scientific value. Dealing with the chemistry of the ancients, Prof. Liversidge said they might include amongst the recent advancements of science the six important volumes recently published by Prof. Berthelot, of Paris (Perpetual Secretary of the Academy of Science and sometime Minister for Foreign Affairs). Referring to the report of the Committee appointed by the London County Council to inquire into the teaching of chemistry, Prof. Liversidge remarked that Australia at present imported most of its scientific men, but it was time it set about educating its own in greater numbers, and providing greater facilities and better equipped laboratories than the existing ones. The prosperity of a country very largely depended upon the advance of science amongst the people and the more or less practical application they made of each science. Students required to be taught not only the principles of science, but also how to observe, how to use their hands, and to reason and think accurately, and to gather their information from various sources; for there were but few, if any, text-books so well written as to be of equal value in all parts. And especially should they have time and opportunity for some original or research work, in order that they might enlarge the borders of knowledge, and contribute something, however small, to the common stock. Mere training and teaching for a degree was not sufficient; post-graduate work was essential if they wished to turn out scientific men, who would be able to advance Australia by developing its resources and improving the conditions of life. It was not sufficient to merely instruct in the facts and principles of scientific knowledge. It was most important also to impart scientific habits of thought and methods, especially with the object of making new investigations or researches, so that the student might in turn be able to teach something more than he himself was taught or learnt from books. With regard to recent work in chemistry, Prof. Liversidge referred to the discovery of argon and helium, and recent work on the liquefaction of gases. He also made brief references to the manufacture of artificial diamonds and other gems, the diffusion of metals, the phenomena of Röntgen radiation, agricultural chemistry, and other subjects of interest.

ASTRONOMY, MATHEMATICS AND PHYSICS.

Astronomy and Terrestrial Physics.

Mr. P. Baracchi (Government Astronomer of Victoria) selected the subject of "Astronomy and Terrestrial Physics" for his presidential address. He pointed out certain branches of astronomy and terrestrial physics which, in his opinion, had the strongest claim to the immediate consideration of the scientific workers of the Australasian Colonies, and in some cases to the encouragement and support of their Governments. After referring to the present observatories in Australia, Mr. Baracchi said it was very necessary for their observatories to be extremely careful with their available astronomical energy in order to turn it to the best possible account, and it should be employed solely in the preparation of data, which were demanded of them, as the most valuable contribution they could give to astronomy at the close of the present and commencement of the next century. Sidereal astronomy was well advanced in the Southern Hemisphere; indeed, it was said ten years ago that they were ahead of the Northern Hemisphere in point of exact star catalogues. In all other respects, however, their knowledge of the Southern Hemisphere was deficient. The course before them was clear. Celestial photography, astronomy of position, and fundamental investigations for the improvement of both these branches should be the chief objects of their endeavours in the present and immediate future. Other branches of astronomical research must be left, and recommended to the amateur astronomers of the Colonies. The best service that could be rendered to astronomy by the amateurs would be to direct their efforts to a class or classes of observations which could not be made by observers in the Northern Hemisphere. With regard to terrestrial physics, there were certain subjects which derived their great importance not only from purely scientific considerations, but from their more or less direct bearing upon material interests, from the fact that in very recent years and at the present time they had been taken up with renewed vigour and determination in the hope of improving our knowledge on many points which still remained unexplained. Prominent amongst these was terrestrial magnetism, from a knowledge of which it was hoped would be gained a solution of some of the riddles which were now unexplained. It was recognised that the main question to which future efforts should be directed was to expand and coordinate magnetic work done all over the world for obtaining a more correct and complete knowledge of the distribution of terrestrial magnetism and of its variations. The establishment of an observatory in the interests of this science was a duty which New Zealand owed to the scientific world.

Cloud Heights and Velocity

A paper on "The Measurement of Cloud Heights and Velocity" was read by Mr. P. Baracchi. The year 1897 had been called by some writers on meteorological subjects "the cloud year," on account of the systematic observations of clouds which were carried on in nearly all the civilised countries during that period under a scheme laid out and finally agreed upon in all its detail by the International Meteorological Committee at its Upsala meeting in 1894. The object of the scheme was to obtain more uniform and comprehensive data to serve as the basis for the further study of atmospheric conditions, as indicated by the forms and movements of clouds. After a brief reference to the methods adopted in Victoria for securing results anticipated by the scheme, Mr. Baracchi said there were now some 20,000 observations ready. For the determination of absolute height and velocity a pair of stations for simultaneous observations were established, one being on the grounds of the Melbourne Observatory and the other on the roof of Parliament House at a distance of 6820 feet bearing. After consideration he adopted the photographic method, which had been successfully employed at the Kew Observatory some years ago. The absolute height and velocity of a cloud could, provided it was suitably situated, be determined from two photographs of it taken simultaneously with two cameras placed at a distance of from a few hundred yards to one or two miles from each other, the cameras being in all respects equal and rigidly mounted, so as to point accurately to their respective zenith, namely, having their collimation axes truly vertical. Under good conditions the highest clouds could be measured within 500 feet and the lower within 50 feet.

The Source of Periodic Waves.

Mr. H. C. Russell, F.R.S., Government Astronomer of New South Wales, read a paper on "The Source of the Periodic Waves, sometimes called Earthquake Waves, which reach Sydney from time to time." He stated that these waves were recorded very frequently in Sydney, and had the same period as the waves known to be caused by earthquakes—that was about twenty-six minutes from crest to crest; but it was shown that only about 1 per cent of them originated in earth movements, and that 60 per cent originated in Bass' Straits, when the meteorological condition known as a low pressure arrived at that part of Australia. The effect of low barometers was to cause a rise in the sea level, to provide for which currents set in along the south and east coasts of Australia, which, meeting in Bass' Straits, produced waves, and set them going in Tasman Sea, whence they were recorded on the Sydney and Newcastle tide gauges. It was also shown that at least another 10 per cent. of these waves originated in Tasman Sea by the action of heavy gales. That was, in all, 70 per cent. of the periodic waves originated from meteorological disturbances, and probably the remainder were due to these causes, although the connec-

tion had not yet been actually traced. Reference was made to Lake George, where somewhat similar periodic waves were frequent, and all were traced to meteorological causes.

Seismological Report.

In presenting the report of the Seismological Committee, the Secretary, Mr. George Hogben, of Timaru, New Zealand, referred to the work already done in his own Colony through the officers of the Telegraph Department, who, on the occurrence of any earthquake shock, filled up certain forms, stating the exact time and duration and such other details of the earthquake as might enable the seismologist to determine the origin of the disturbance, the velocity with which the waves were propagated through the earth's crust, and sometimes to make a very good guess as to the nature of the subterranean causes that gave rise to the earthquake. By means of these observations the sources of many of the earthquakes had been accurately found, their velocity of propagation determined, as in general rather under twenty miles a minute; in a few cases the depth of the origin was also ascertained, the deepest one found so far coming from a point about twenty-four miles below the earth's surface. This work had been done in New Zealand since 1889, and the other Colonies had been asked to follow suit. This they had done to a certain extent, but the Committee was anxious that the system should be developed, and made uniform throughout. Of recent work the most interesting item was probably the fact, based upon rough calculations from returns sent by Sir Charles Todd, and others, that the great South Australian earthquake of May 10, 1897, proceeded from a line parallel to the coast near Beachport and Kingston, and was possibly due to a sliding of one part of the crust upon another, such as forms what was called in geology a "fault." This was probably deep, but the later and slighter shocks were surface ones, caused by readjustments of the immediate crust. The subject was still under investigation by the Secretary. But Mr. Hogben pointed out that it was as part of a world-system of seismological observations that the work of the Committee might be most useful. An International Seismological Committee had been set up embracing all the ablest workers in every part of the world, and in co-operation with that Committee were Committees of the British Association and of the Royal Society. They desire especially to be able to track the microseismic vibrations of minute earthquake waves, which travelled from the sources of disturbance all round the earth's surface, or it might be right through the solid mass of our world (if it was solid). The speed of these finer waves was many times greater than that of the larger waves felt by us, reaching a velocity as great as twelve miles per second, or even more. For the purpose of observing them the International Committee had agreed upon a certain type of instrument, the horizontal pendulum to be used by all stations alike, as it was important that instruments of the same kind and of the same degree of sensitiveness should be employed for purposes of comparison.

Mr. Hogben stated in answer to questions that, at the suggestion of Sir James Hector, the New Zealand Government had ordered two instruments—improved forms of the horizontal pendulum. He asked for the moral and financial support of the Association in this object. Unless instruments were procured at once for Sydney, Melbourne and Timaru (the three stations in Australasia named by the International Committee), the chain of world-stations would be interrupted.

Chemistry.

Constitution of the Matter in the Universe.

The New South Wales Government Analyst, Mr. William M. Hamlet, delivered the presidential address in this section, the subject being "The molecular mechanism of an electrolyte." He defined an electrolyte as a body in solution or state of fusion, capable of being instantaneously decomposed by a current of electricity, and he claimed that if the explanation he offered was adequate for the electrolyte, it must hold good for the constitution of the matter in the universe, so that the treatise on the electrolyte has a most important scientific bearing. The method of investigating the action of one body upon another, he reminded his audience, was brought to a high degree of accuracy by the immortal work of Sir Isaac Newton. He alluded to some observations of the late Prof. Clifford, made over twenty years ago, this authority remarking, almost prophetically, "We can look forward to the time when the structure and motions in the inside of a molecule will be so well known that some future Kant or Laplace will be able to make an hypothesis about the history and formation of matter."

Red Rain Dust.

Much interest was manifested in a paper read by Mr. Thomas Steel on "Red Rain Dust," in the section devoted to chemistry and chemical research. The author remarked that from time to time records of the fall of dust, either alone or accompanied by rain, have been reported from various parts of the Australian Colonies, in common with the rest of the world. Although it was extremely probable that in the great bulk of the cases the dust was merely of terrestrial origin, it was interesting when positive facts regarding the source of the material could be ascertained. On December 27, 1896, an unusually heavy fall of dust of a red colour occurred in Melbourne and was carried down by rain.

An analysis of a clean sample of this dust gave the following results:—Organic matter, 10·70; sand, insoluble and undetermined, 66 21; soluble silica, ·75; ferric oxide, 4·68; ferrous oxide, ·50; alumina, 15·16; lime, 1·36; sulphuric anhydride, ·62. The dust may therefore be regarded as a characteristic example of ordinary surface soil, such as is derived from the weathering of volcanic rocks. Both in appearance and composition it agreed closely with several samples of such soil from widely separated localities. Under the microscope, in addition to the diatoms noticed by other observers, the dust was seen to contain a few lepidopterous scales.

Geology and Meteorology.

Early Life on the Earth.

In this section the President, Prof. F. W. Hutton, F.R.S., delivered an address on the subject of "Early Life on the Earth." After describing the various periods through which the earth has passed, Prof. Hutton presented some speculations regarding pre-Ordovician life. Speaking of the origin of life, he said it was highly probable that the first living organisms were evolved near the surface of a warm ocean. They might safely assume that the first protoplasm was not so complicated a substance as it had since become. Ordovician and Silurian life followed, and the lecturer said, in conclusion: "We have thus arrived at the conclusion that the ocean was the mother of life; that on its surface floated the first organisms whose descendants, but little changed during all the millions of years that have since passed away, still float and multiply. Presently some of these animals found their way down to the bottom, where all the débris from the floating organisms collected, and here in still water they lived and increased for a long time. Slowly they invaded the rough waters of the coastline, and at last gained a footing on the land. It was plants which formed the army of invasion that conquered the land."

Coral-boring Expedition to the South Seas.

Considerable interest was manifested in the section devoted to geology and mineralogy, owing to the fact that Prof. David was announced to read a paper on "The Coral-boring Expedition of 1897 to the Island of Funafuti in the South Seas." The funds for the expedition were found chiefly by Miss E. Walker, of Yaralla, the late Mr. Ralph Abercrombie, and the Royal Society of London, while the New South Wales Government lent a diamond drill and the workmen. The method of working the drill and simultaneously attacking the great coral cliff which bounds the atoll seawards was explained, and an account given of some of the manners and customs of the natives. Special reference was made to the nature of the last part of the boring done while Mr. Sweet was in charge. The last 30 feet of core were particularly interesting, being formed of a soft chalky rock, with numerous foraminifera, and showing that the coral formation proper had been all but completely penetrated. Had it been possible to bore a little deeper, Prof. David thinks that the foundation rock would have been reached. Mr. Sweet had done all that he judged would most conduce to attaining this end, and when the boring had to be stopped had left the bore in such a condition that it was possible in resuming the bore to utilise the old borehole, now 698 feet deep. Prof. David urged that this meeting might use its influence with the Council of the Association to have a recommendation made to the Government of New South Wales to extend the loan of the diamond drill so as to admit of the boring being continued till bedrock was

reached. A letter received from the Royal Society of London, stated that the Society was so pleased with the results already attained at the Funafuti bore, that it had voted a further sum to meet the expenses, making their total subscription up to the present 500*l*. Opinions amongst scientific men in Great Britain as to the conclusions to be drawn from the evidence of the Funafuti bore were at present divided. While the advocates of the Darwinian theory were inclined to congratulate themselves upon the results, Dr. Murray's supporters say that the evidence substantiates their views. Prof. David considered that the last portion of the core obtained weakened the subsidence theory.

Glacial Research.

The report of the Glacial Research Committee, South Australia, was submitted by Prof. T. W. E. David and Mr. Walter Howchin. The localities dealt with were comprised within the peninsula which formed the southern limits of the Mount Lofty Range. In 1859 Mr. Alfred Selwyn, at that time Government Geologist of Victoria, whilst travelling through the Inman Valley, discovered a polished rock surface which, to the practised eye, exhibited clear proof of glacial action. This was the earliest discovery of its kind in Australia, but the position was lost sight of until re-discovered by the authors of the paper in March last. This polished pavement, which measured over 20 feet in length and 6 feet in breadth, occurred in the bed of the Inman River, a little past the seventh mile-post from Port Victor. The glacial beds of the Inman River have at present an elevation of over 600 feet above sea level. If, therefore, the agency of shore-ice as the means of distribution were admitted they must assume that there had been an elevation of the land since the days of glaciation. The facts were, perhaps, best explained by a reference to a combination of agencies, rather than to a single form of ice action.

A paper "On the Occurrence of Glacial Boulders at Yellow Cliff, Crown Point Station, Fincke Valley, Central Australia," dealt with a recent discovery by Prof. Baldwin Spencer, of Melbourne University, and Mr. P. M. Byrne, of Alice Springs telegraph station, of large glaciated pebbles at a level of about 1000 feet above the sea. This is the nearest point to the tropics in Australia at which traces of glacial action have been observed, and the discovery is therefore of great interest. The pebbles are from 2 inches up to 1 foot in diameter, and form a layer about 3 feet in thickness, overlying a soft grey sandstone, the geological age of which is unknown. It is not known at what period of geological time the ice existed which produced these markings. The only other instance of possible evidence of ice action in Australia near to the equator than Yellow Cliff is that mentioned by Mr. R. L. Jack, viz. the Bowen River coalfield of Queensland. At that locality small boulders of rock foreign to the district are found embedded in the marine permo-carboniferous strata. It is just possible that these boulders were rafted to their present resting-place by floating trees, but the glacial explanation is thought to be the more probable one.

A paper entitled "Further Evidence of Glacial Action in the Bacchus Marsh District," by C. C. Brittlebank, G. Sweet, and Prof. David, dealt specially with the deep preglacial valleys bounded by steep sides, 500 to 600 feet high, which had been choked with glacial drift, and powerfully glaciated at their bottoms and sides, as well as on the summits of the intervening ridges. The fact was commented on that very few rocks of local origin were observable in the glacial beds, and that all the glacial beds were more or less stratified, in which respect they differed markedly from the glacial till of Northern Europe.

Geology and Mineral Deposits of Portions of West Australia.

The New South Wales Government Geologist (Mr. E. L. Pittman), read a paper "On the Geology and Mineral Deposits of certain portions of West Australia." The geology of the Perth artesian water basin was first dealt with, and it was stated that the water occurred in a porous rock, consisting of calcareous sandstone of æolian origin. The basin was about fifteen miles wide, but extended along the coast for several hundred miles in a north and south direction. The chief peculiarity of this artesian basin was that it was not covered by any continuous impervious beds, such as had hitherto been regarded as essential for the occurrence of artesian water. Reference was next made to the Collie coalfield, and the opinion was expressed by the author that it was of Mesozoic age, like the Victorian coalfields, and that of the Clarence River. The Coolgardie goldfield was then briefly alluded to. The gold here occurred in some of the reefs in phenomenally rich "chutes," separated by intervals of barren material. The "cement deposits" of the 25-Mile were described as alluvial deposits, containing very angular gold, in fairly-defined channels. The Kalgoorlie goldfield was described at considerable length, and particular reference was made to the famous telluride deposits of the Boulder. These, in Mr. Pittman's opinion, consisted of igneous dykes of quartz, felspar, porphyry, which had been subjected to an enormous amount of crushing, and this had induced a schistose or foliated structure in them.

General Geology.

The Rev. J. Milne Curran read a paper on "Artesian Water in New South Wales." He concluded that the artesian water of the north-west and west of New South Wales was derived from Triassic beds, and, in his opinion, there was no evidence to show that a single artesian well in the Colony derived its waters from Cretaceous rocks. Photographs were exhibited of artesian flows, Cretaceous and Silurian country in the far west.

In the discussion that followed, Mr. R. L. Jack stated that artesian water had just been struck in Queensland, on the central line of railway at Maria Creek, west of the Dawson River, in rocks of permo-carboniferous age. These were the oldest rocks in Australia in which artesian water has as yet been discovered, and they were not known previously to be water-bearing.

The Rev. J. Milne Curran, in laying before members of the section some "Notes of a Geological Reconnaissance on the Mount Kosciusko Plateau," said that his conclusions were (1) that there was no satisfactory evidence of extensive glaciers having existed in the present valleys, under the highest peaks of Mount Kosciusko; (2) that there was no evidence of extensive glaciation on the Kosciusko plateau; (3) that the "glacial epoch of Australia" in post-Tertiary times, as described by Dr. Lendenfeld, had no foundation in fact.

BIOLOGY.

Relations of Morphology and Physiology.

The President of this section, Prof. C. J. Martin, dealt, in his opening address, with the growth of the science of morphology, which was now a separate science from physiology; the scope of research in both directions having, within the last fifty years, become greatly widened. Morphology deals with the structural conformation and anatomy of animals; physiology, with the functional workings of the animal system. During the last half-century the discoveries in both these sister sciences have been of a most beneficial character to mankind, and the future was full of possibilities. Prof. Martin did not let the occasion pass without bearing testimony to the ungrudging and valuable services of the late Prof. Jeffery Parker, during his term of the presidency of the section.

GEOGRAPHY.

Submarine Geography.

The President, Sir James Hector, K.C.M.G., F.R.S., in his presidential address, dealt at length with the subject of "Submarine Geography." Since their last meeting, Sir James said, the results of the exploring expeditions equipped by the munificence of the late Sir Thomas Elder and Mr. Horn had been made public, and the wonderful expansion of our knowledge of the central and western parts of the continent obtained through the intrepid journeys would greatly assist the material development of the vastly rich but hitherto neglected interior area of Westralia. Another feature of great promise to the future advance of geographical discovery in the more difficult parts of the Australian continent was the steady extension of the "artesian well" system into the arid areas of the interior, where the absence of water had not only prevented the settlement of the country, but even its exploration, and had caused the loss of many brave and enthusiastic pioneers under circumstances of intense personal suffering. When the sources of underground water circulation were fully comprehended and utilised, both exploration and occupation of large and almost unknown areas would become possible. After dealing with geographical researches conducted in different parts of the world, the President said the crowning event that had absorbed the interest of geographers since the last meeting was the successful achievement of Nansen. The scientific results of this wonderful venture had not yet been published, but two remarkable advances in geographical science

were announced: (1) that the North Polar Ocean was not a shallow sea, with scattered islands, distributing icebergs, but a profound ocean basin; (2) that there were definite movements of the great ice cakes, and that they crossed, and did not merely circulate round the pole.

Antarctica.

"Antarctica" was the subject of a lecture delivered by Sir James Hector, the president of the geographical section. The Antarctic Continent, or Antarctica, as it had been recently called, was an immense area of about 4,000,000 square miles; but they knew very little about it. There had been a number of expeditions to the North Pole, but very little had been done in the way of obtaining knowledge with regard to the South Pole. The last expedition by Nansen had proved that the North Polar region was a great cavity, nearly two miles deep, instead of being, as hitherto supposed, an island with half-open seas. The Antarctic regions, on the other hand, consisted of a great solid mass of land, extending far beyond the area explored by Nansen at the North Pole. Captain Cook, in 1776, furnished the first information with regard to the Antarctic regions; but it was not until Ross' expedition in 1841, followed by the *Challenger* in 1874, that any accurate information was obtained in regard to this continent. By means of his sounding apparatus, Ross made the discovery that there was a belt of water two miles in depth right round the Antarctic regions. In some places it showed a depth of 2000 fathoms, and in other places 4000 fathoms, without any bottom. Ross discovered Victoria Land, a mountain promontory stretching for 500 miles north and south, during which he passed through a belt of ice over 100 miles in width into calm, beautiful water beyond. Ross sailed south to latitude 78°, where he found volcanic mountains from 12,000 to 15,000 feet high, towering above a vast range of snowy mountains, and vomiting forth flames and lava. Huge glaciers descended for miles into the sea; but along the rocky shore no landing-place could be found, there being no harbour or indentation of any kind. A landing was, however, effected on Possession Island, which lay a short distance off the mainland. He attempted to reach the mainland from this island, but failed, and, turning eastward, he found a perpendicular wall of ice 200 feet high, and he traced it for 300 miles without a break. On some days the sun shone out with great brilliancy from a perfectly serene and clear sky of intense blue. Reference was made to the atmospheric conditions and currents of the Antarctic region, and then Sir James pointed out that within this circle no living thing had yet been found which belonged to the land. The life-history of the birds was most remarkable, because they could not breed within the Antarctic circle owing to there being no place for them to build their nests, except ice that was melting. In concluding, Sir James expressed the hope that the exploration of Antarctica would be continued. One of the most important things to be done in this direction was to settle the exact position and intensity of the magnetic pole, especially in the interests of navigation. Until they had established by survey the magnetic conditions of the southern end of the globe, careful and scientific provision could not be made for the safety of iron ships steaming upon different courses.

Australian Oceanography.

"A Contribution to Australian Oceanography" was the title of a paper by Mr. T. W. Fowler. The paper was suggested by the reports of the *Challenger* expedition, which seemed to leave room for much further investigation. An attempt had been made by the writer to get additional information, and with this end in view he had obtained from the captains or officers of various intercolonial steamships proceeding at regular intervals, samples of water passed through by them, together with the temperature of the sea at the time the sample was obtained. The samples were taken as near the vessels' bows as possible, and placed in well-cleaned bottles, which were tightly corked and forwarded to Mr. Walker for examination at the Melbourne University. Mr. Buchanan's method of conducting the examination was adopted. Two hydrometers were used, and the results were checked by testing the instruments in solutions of known densities. Tables were given showing the densities of waters obtained between Fremantle and Melbourne; between Melbourne and Brisbane; on the east coast of Australia generally; between Melbourne and the Bluff; on the Sorrento Back Beach, Bass Strait, and a number of other places.

Remarks on Central Australia.

"Notwithstanding the labours of the past, the last volume of Australian discovery is still incomplete," was the opening remark of the paper by Mr. W. H. Tietkins, who in 1889 led an expedition, which was fitted out under the auspices of the South Australian branch of the Royal Geographical Society, one of the objects of which was to determine the outline of Lake Asmodeus in Central Australia. Mr. Tietkins suggested that attention should be directed to the Rawlinson and Peterman Ranges, which lie to the north of the Mann and Tomkinson Ranges, and which were bounded on all sides by barren and inhospitable sandy wastes. To the best of his belief these ranges had not been visited, except by Giles, whose party was much reduced. These ranges formed an extensive and fertile field for systematic and scientific examination. It was suggested that a party might leave the settlements at Giles Range or Erldunda, and proceed from there to Mount Olga, where the first depôt would be formed, pending the discovery of suitable water being found further west and nearer the scene of operations. No difficulty would be experienced in reaching Sladen Water. It might be almost taken for granted that valuable waters would be found before reaching so far west. From the western end of the Rawlinson Range the party could return by a slightly different route, and if time and circumstances allowed before leaving Sladen Water. The conviction was forced upon him that no pasture lands of sufficient extent might be looked for that would develop the western interior, but the hope might reasonably be entertained that the mining industry in that latitude would challenge the enterprise of the Australian people.

ETHNOLOGY AND ANTHROPOLOGY.

The Origin of the Aborigines of Tasmania and Australia.

This was the subject chosen by Mr. A. W. Howitt, President of the ethnological and anthropological section, for his presidential address. He was of opinion that, in spite of the contention of many writers to the effect that the primitive Australians and Tasmanians had come from other lands in ships or canoes, there were but little evidences to show that they had any knowledge of navigation or of sea-going vessels. In any solution of the origin of the natives of Australia one fundamental element must be that the ancestors of these savages reached Australia or Tasmania by land; or if the land connection was not continuous, the intervening channels were such as could be traversed by vessels no better than the catamarans or canoes above mentioned. The lecturer quoted many geological facts, all of which tended to show that an immense period of time was one of the elements of any solution of the problem, and that during that period the Australians had been isolated from outside influence, having at the same time a continental area in which to develop their institutions. The level of culture of the Tasmanian had been termed the eolithic, and that of the Australians might fairly be termed neolithic, or even as regards some of the tribes of Central Australia bordering on the palæolithic. The social organisation of the Tasmanians was also below the level of that of the Australians. Finally he came to the conclusion that the Australlans reached the continent by a land bridge connecting with the Indo-Asiatic continent or by a land extension of the Austral continents to the north-west or over some shallow channels separating Australia from these lands.

A lecture on "Native Life in Central Australia" was delivered by Prof. W. Baldwin Spencer. After describing the difficuities of travelling, the lecturer remarked that the country was divided into the lower steppes, the desert country, and the higher steppes, where the James and Macdonell Ranges rear their lofty summits sometimes to a height of 5000 feet. Lake Amadeus in the dry season is a mere sheet of salt. Ayers Rock, another remarkable formation of this distant and mysterious land, rises abruptly from the surface of the desert country. It is about one mile long and five miles in circumference. Formerly there were vast rivers here, and animals, such as the diprotodoton, a wombat-like creature about four times as large as a kangaroo, flourished on the plains. Now animal life was scarcely noticeable. The fish lived in the waterholes in the hills until the wet season came and washed them down the foaming gorges of the mountain to the lower lands. In the dry season the water-frog fills himself up with water, and, rolling himself into the mud, exists there until the next rains, which may not come for two years. In

the meantime the frog may have the misfortune to provide a drink for a thirsty native. The natives also obtain water from the roots of trees. They all believed that each one was under the ægis of the spirit of some animal or plant, which they revered almost as gods. In connection with the tokens, they held all sorts of weird ceremonies, bedecking themselves with great elaborateness, and going through all sorts of antics, such as imitating frogs, emus, kangaroos, or whatever it was they held in veneration. Group marriage prevails; that is, men in one group can only marry the women in another single group. The Engwurra, or the fire ceremony, through which a youth has to pass before being entitled to be considered a man, seems to be peculiarly exacting to the candidate for manhood.

RESOLUTIONS OF COUNCIL.

At the final meeting of the General Council on January 13, the following suggestions from the Recommendation Committee were agreed to:—(1) That the New South Wales Government acquire the quarry of prismatic sandstone at Bondi, with a view to its preservation as a remarkable geological occurrence. (2) The re-appointment of the Committee on "The Systematic Conduct of the Photographic Work of Geological Surveys." (3) The appointment of a Seismological Committee for 1900. The Government of New Zealand to equip Timaru with approved seismological instruments, in charge of Mr. George Hogben. A contribution of 25*l.* was voted towards the preceding object. (4) The appointment of a Committee to secure magnetic surveys at the extreme south of New Zealand. (5) Expressing the opinion that the publication of Victorian continuous magnetic records is desirable. (6) That the Committee be re-appointed to continue the investigation of the mineral waters of Australasia. (7) That the New South Wales Government be recommended to complete the borings at Funafuti while the bore apparatus remains on the island, and the bore remains open. (8) A Committee be appointed to draw up a list of works and papers relating to Australian flora.

The report from the Baron von Mueller Memorial Committee, embodying a resolution, "That the Association places on record its sense of the deep loss sustained by it owing to the death of the late Baron von Mueller, and its high appreciation both of his personal character and the distinguished services rendered by him to science," was adoped.

On the motion of Prof. Kernot, of Melbourne, seconded by Prof. Baldwin Spencer, Mr. R. L. J. Ellery, late Government Astronomer of Victoria, was elected to be President of the Science Congress to be held in Melbourne in the year 1900. Mr. C. R. Blackett, Government Analyst of Victoria, was elected treasurer, and Prof. Baldwin Spencer and Mr. E. F. J. Love were elected joint secretaries for the same Congress. It was decided that the next meeting of the Asssociation after the one to be held in Melbourne will take place at Hobart.

FORTHCOMING BOOKS OF SCIENCE.

IN Messrs. Baillière, Tindall, and Cox's list are to be found:—"A Manual of Surgery," by Drs. William Rose and Albert Carless; "Atlas of Traumatic Fractures and Dislocations," by Prof. H. Helferich (vol. vi. "Hand-Atlas" Series); "English-French and French-English Dictionary of Medical Terms," by H. de Méric, two parts; "Minor Surgery and Bandaging," by Dr. W. G. Spencer, illustrated; "Respiratory Exercises," by Dr. Harry Campbell; "Diagnostic Signs in Women," by Dr. T. W. Eden; "The Clinical Diagnosis of Lameness in the Horse," by W. E. A. Wyman, illustrated; "Practical Toxicology for Physicians and Students," by Prof. Dr. Kobert, translated and edited by Dr. L. H. Friedberg; "Chronic Nasal Obstruction, and Deformities of the Upper Jaw, Teeth, and Palate," by Dr. Mayo Collier; "Atlas of Pathological Anatomy," by Prof. O. Bollinger (vol. vii. "Hand-Atlas" Series), illustrated; "Idiopathic Ulcerative Colitis (Dysentery)," by J. F. Gemmel, illustrated; "Water" (Part ii. of the "Analysis of Food and Drugs"), by T. H. Pearmain and C. G. Moor; and new editions of "A Guide to the Examinations of the Conjoint Board in England and for the Fellowship of the College of Surgeons, with Examination Papers," by F. J. Gant; "Heart Disease, with special reference to Prognosis and Treatment," by Sir William Broadbent, Bart., and Dr. J. F. H. Broadbent; "Diseases of the Throat and Nose," by Lennox Brown, illustrated; "Applied Bacteriology," by T. H. Pearmain and C. G. Moor; "The Practical Guide to the Public Health Acts and Correlated Acts for Officers of Health and Inspectors of Nuisances," by Dr. Thomas Whiteside Hime; "Latin Grammar of Pharmacy," by Joseph Ince; "A Manual of Artistic Anatomy for the Use of Students in Art," by John C. L. Sparkes, with plates; "Handbook for Attendants on the Insane"; "The Register of the Royal College of Veterinary Surgeons."

Messrs. Wm. Blackwood and Sons' list includes:—"A Text-book of Modern Geometry," by J. A. Third; "Lower Geometrical Exercises," by the same author; "Higher Geometrical Exercises," by the same author; "The Elements of Physical Education, a Teacher's Manual," by Dr. David Lennox and Alexander Sturrock, with Original Musical Accompaniments to the Drill by Harry Everitt Loseby, illustrated; "A Manual of Agricultural Botany," from the German of Dr. A. B. Frank, translated by Dr. John W. Paterson, illustrated; and new editions of Sir John Skelton's "The Handbook of Public Health," revised by James Patten MacDougall and Abijah Murray, Part ii. containing other Acts bearing on Public Health, with Notes, Forms, &c.; "Introductory Text-book of Zoology," by Prof. Henry Alleyne Nicholson, F.R.S., and Dr. Alexander Brown, illustrated; "Page's Introductory Text-book of Geology," revised and enlarged by Prof. Lapworth, F.R.S.; "Page's Advanced Text-book of Geology," Descriptive and Industrial, with engravings, and Glossary of Scientific Terms, revised and enlarged by Prof. Lapworth, F.R.S.; "Introductory Text-book of Meteorology," by Dr. Alexander Buchan, illustrated; "Dr. Mackay's Elements of Physiography," illustrated.

Messrs. Bliss, Sands, and Co. announce:—The Progressive Science Series: "Earth Structure," by Prof. Geikie, F.R.S., illustrated; "Volcanoes," by Prof. Bonney, F.R.S., illustrated; "The Groundwork of Science," by Dr. St. George Mivart, F.R.S.; "Vertebrate Palæontology," by Prof. Cope, illustrated; "Science and Ethics," by M. Berthelot; "The Animal Ovum," by F. E. Beddard, F.R.S., illustrated; "The Reproduction of Living Beings: a Comparative Study," by Prof. Marcus Hartog, illustrated; "The Study of Man: an Introduction to Ethnology," by Prof. A. C. Haddon, illustrated; "Man and the Higher Apes," by Dr. Keith, illustrated; "Heredity," by J. Arthur Thomson, illustrated.

Messrs. Burns and Oates, Ltd., promise:—"Genesis and Science," by John Smyth.

The list of the Cambridge University Press includes:—Cambridge Natural Science Manuals, *Biological* Series: "Fossil Plants, a Manual for Students of Botany and Geology," by A. C. Seward; "Vertebrate Palæontology," by A. S. Woodward.

Messrs. Cassell and Co., Ltd., announce:—The "Century Science" Series: "Michael Faraday, his Life and Work," by Prof. Silvanus P. Thompson, F.R.S.; "Cassell's Family Doctor," by a Medical Man; and new editions of "The Story of Our Planet," by Prof. Bonney, F.R.S., with coloured plates and maps, and illustrated: "The Story of Africa and its Explorers," by Dr. Robert Brown, 4 vols., illustrated; "The Countries of the World," by Dr. Robert Brown, vol. v., illustrated.

Messrs. Chapman and Hall, Ltd., will issue:—"Physics, Experimental and Theoretical: an Elementary Treatise Mechanics, Hydrostatics, Pneumatics, Heat and Acoustics," by Dr. R. H. Jude and H. Gossin, illustrated; "The Manufacture of Boots and Shoes," being a modern treatise of all the processes of making and manufacturing footgear, by F. Y. Golding, illustrated; "Notes on Carpentry and Joinery," adapted to the requirements of the City and Guilds of London Institute, the Worshipful Company of Carpenters, and the County Council's Scholarship Examinations, by J. T. Evans: Second Stage, Ordinary or Advanced Course, illustrated; "Chinese Porcelain," by W. E. Gulland, illustrated; "De Pontibus, a Pocket-book for Bridge Engineers," by J. A. L. Waddell; "Machine Design," Part i. "Kinematics of Machinery," by Prof. Forrest R. Jones; "Handbook of Street-Railroad Location," by Prof. John P. Brooks; a new edition of "A Text-Book of Mechanical Engineering." by W. J. Lineham, illustrated.

Messrs. Chatto and Windus promise new editions of: "Flammarion's Popular Astronomy," translated and edited by J. Ellard Gore, illustrated; "Popular Astronomy," by J. Rambossom, translated by C. B. Pitman, illustrated.

Messrs. J. and A. Churchill will publish:—"Manual of General Pathology for Students and Practitioners," by Dr.

Lazarus-Barlow; "Manual of Bacteriology," by Dr. Hewlett; "Manual of Dental Metallurgy," by Ernest A. Smith; and a new edition of "Manual of Dental Anatomy, Human and Comparative," by Charles S. Tomes, F.R.S.

The Clarendon Press will issue:—"Essays on Secondary Education," edited by C. Cookson.

In the announcements of Mr. Clive, of the University Correspondence College Press, we find:—"A Manual of Psychology," by G. F. Stout; "The Tutorial Algebra," by W. Briggs and Prof. G. H. Bryan, F.R.S., Part i., Elementary Course, Part ii. Advanced Course; "Properties of Matter," by E. Catchpool; "Advanced Sound, Advanced Light, First Stage Magnetism and Electricity," by Dr. R. H. Jude; "Advanced Magnetism and Electricity"; "Text-book of Zoology," by A. M. Davies; "Text-book of Botany," by J. M. Lowson; "Advanced Chemistry: First Stage Practical Inorganic Chemistry, Practical Organic Chemistry," by George George; "First Stage Mathematics, Stage ii. Mathematics," by J. H. Grace; "Key to First Stage Mechanics of Solids"; "Coordinate Geometry, Part ii."; "Tutorial Dynamics," by W. Briggs and Prof. G. H. Bryan, F.R.S.; Supplement (on Metals) to Tutorial Chemistry, Part i.. "An Introduction to Carbon Compounds," by Dr. F. Beddow; "Quantitative Analysis, a Sequel to the Analysis of a Simple Salt"; "First Stage Physiology"; "Advanced Physiology"; "First Stage Geology"; "Advanced Geology"; "First Stage General Biology"; "Advanced General Biology"; First Stage Botany"; "Advanced Botany"; "First Stage Agriculture"; "Advanced Agriculture"; "First Stage Hygiene"; "Advanced Hygiene"; and new editions of "Matriculation Mathematics" and "First Stage Mechanics of Fluids."

Messrs. A. Constable and Co. will issue:—Constable's Technical Series: "The Internal Wiring of Buildings," by H. M. Leaf, illustrated; "The Electrical Equipment of Tramways," by H. F. Parshall and Evan Parry, illustrated; "Electro-Metallurgy," by Bertram Blount, illustrated; "Auto-cars and Horseless Carriages," by Dugald Clerk and Worby Beaumont, illustrated; "The Steam Boiler," by H. H. Powles; "The Life of Sir Charles Tilston Bright," by Edward Brailston Bright and Charles Bright, 2 vols., illustrated; "The Simplest Living Things," by Prof. E. Ray Lankester, F.R.S., illustrated; "Electricity in Town and Country Houses," by Percy E. Scrutton, illustrated.

Messrs. J. M. Dent and Co. promise:—"With Ski and Sledge over Spitsbergen Glaciers," by Sir William Martin Conway, illustrated.

Messrs. Duckworth and Co.'s list contains:—"Savage Philosophy in Folk-Tale," by Edward Clodd.

Messrs. Friedländer and Sohn (Berlin) will publish:—Britzelmayr's "Zur Hymenomyceten-Kunde," vol. iii. (and last), illustrated; Gerberte's (Papae Silvestri II) "Opera Mathematica," illustrated; A. Bolles Lee's "The Microtomist's Vademecum," German translation, with many additions by the author and Prof. P. Mayer; A. B. Meyer and L. W. Wiglesworth, "The Birds of Celebes and the Neighbouring Island, 2 vols., illustrated; Das Tierreich (the publication of the German Zoological Society), next part, Rothschild's "Paradiseidae"; Trouessart's "Catalogus Mammalium," vol. iv. (and last).

Messrs. Gauthier-Villars et Fils (Paris) announce:—"Eléments de la Théorie des Fonctions elliptiques, by Tannery et Molk," Tome iii.; "Leçons sur la Théorie des marées fluviales et terrestres," by Maurice Lévy.—"Œuvres de Laplace," Tome xii.; "Recueil de données numériques publié par la Société Française de Physique, Optique," by H. Dufet, 1er fascicule; "Œuvres mathématiques de Riemann, traduites," by L. Laugel; "Traité d'algèbre supérieure," by Weber, traduction de Griess; "Leçons nouvelles sur l'analyse infinitésimale et ses applications géométriques," by Méray, Tome iv.; "Distribution de l'énergie par courants polyphasés," by J. Rodet; "Traité pratique de photogravure," by Léon Vidal; "Les Eléments d'une photographie artistique," by Robinson, traduction de H. Colard.

Mr. Heinemann announces:—"A translation of Prof. Müller's work on Krupp's Steel Works," illustrated.

The list of Mr. Hoepli (Milan) contains:—"Coniglicoltura pratica," by Giuseppe Licciardelli, illustrated; "La Sieroterapia," by Dr. E. Rebuschini; "Agronomia e Agricoltura moderna," by Giovanni Soldani; "Astronomia Nautica," by Dr. Giuseppe Naccari; "Luce e raggi Röntgen," by Prof. O. Murani.

Messrs. Hutchinson and Co. promise:—"The Origin and Nature of Man," by Dr. S. B. G. McKinney.

Messrs. Innes and Co. announce:—"Through the High Pyrenees," by Harold Spender and Llewellyn Smith.

Messrs. Lawrence and Bullen, Ltd., will add to their "Angler's Library":—"Salmon and Sea Trout," by Sir Herbert Maxwell; "Trout, Char, &c.," by T. D. Croft.

Mr. H. K. Lewis's list is as follows:—"A Handbook of Diseases of the Nervous System," by Dr C. E. Beevor; "Prof. Furbringer's Diseases of the Kidneys and Genito-Urinary Organs," vol. ii.; "Inflammation of the Bladder," by Dr. Mansell Moullin; "Yellow Fever in the West Indies," by Dr. Izett Anderson; and new editions of Prof. Corfield's "Dwelling Houses; their Sanitary Construction and Arrangements"; Dr. Dudley Buxton's "Anæsthetics"; Dr. Samuel Rideal's "Practical Organic Chemistry."

Messrs. E. and S. Livingstone (Edinburgh) call attention to:—"Practice of Medicine" (Catechism Series), Part iii.; and a new edition of Husband's "Practice of Medicine."

Messrs. Longmans and Co.'s announcements include:—"Essentials of Practical Bacteriology," by Dr. Henry J. Curtis, illustrated; "The Diseases and Injuries of the Lungs and Pleura," by Dr. James Kingston Fowler and Dr. Rickman J. Godlee, illustrated; the Memorial Edition of the late Mr. John Ball's "Alpine Guide," issued by the Alpine Club: vol. i. "The Western Alps," vol. ii. "The Central Alps, North of the Rhone Valley, from the Simplon Pass to the Adige Valley"; "The Training of Young Children," by Ennis Richmond (Mrs. Wilfrid Richmond); "Outlines of Descriptive Psychology: a Text-book of Mental Science for Colleges and Normal Schools," by Prof. George Trumbull Ladd.

Messrs. Sampson Low and Co., Ltd., give notice of:—"Twentieth Century Practice, an International Encyclopædia of Modern Medical Science by Leading Authorities of Europe and America," edited by Dr. Thomas L. Stedman, in 20 vols.: vol. xii. "Mental Diseases, Childhood and Old Age," vol. xiii. "Introduction to Infectious Diseases"; "A Complete System of Nursing," written by various contributors, and edited by Honnor Morten; "Petroleum Motor-cars," translated from the French of Louis Lockert; "Twenty-five Years in British Guiana," by Henry Kirke, illustrated, and a new edition of "The Care of the Sick at Home and in the Hospital," by Dr. Th. Billroth, translated by J. Bentall Endean, illustrated.

Among the announcements of Messrs. Macmillan and Co., Ltd., we notice:—"The Scientific Papers of Thomas Henry Huxley," reprinted from the journals of scientific societies, edited by Profs Michael Foster and E. Ray Lankester, F.R.S., in four vols., vol. i.; "Essays on Museums and other Subjects connected with Natural History," by Sir William Henry Flower, K.C.B., F.R.S.; "A Text-Book of Botany," by Drs. E. Strasburger, Fritz Noll, H. Schenck, A. F. W. Schimper, translated from the German by Dr. H. C. Porter, illustrated; "A System of Medicine," edited by Prof. Thomas Clifford Allbutt, F.R.S., vol. v.; "Elementary Course of Physics," edited by Rev. J. C. P. Aldous (Britannia Series), in three parts: Part i. Mechanics, Properties of Matter, Hydrostatics, Heat; Part ii. Wave Motion, Sound, Light; Part iii. Magnetism, Electricity; "Elementary General Science," by A. T. Simmons and Lionel M. Jones, illustrated; "Electro-Physiology," by Prof. W. Biedermann, translated by Frances A. Welby, vol. ii.; "Notes on Observations, being an outline of the methods used for determining the meaning and value of quantitative observations and experiments in physics and chemistry, and for reducing the results obtained," by Sydney Lupton; "The Cambridge Natural History," edited by S. F. Harmer and A. E. Shipley, vol. ix. "Birds," by A. H. Evans, illustrated.

Messrs. Methuen and Co. call attention to:—"Three Years in Savage Africa," by Lionel Decle, illustrated; "Exploration and Hunting in Central Africa," by Major A. St. H. Gibbons, illustrated; "The Niger Sources," by Colonel J. Trotter, illustrated.

Mr. Murray promises:—Mr. Arthur Berry's "Manual of Astronomy," illustrated; "Early Chapters in Science," by Mrs. Awdry (wife of the Bishop of Japan); "Five Years in Siam," by H. Warington Smyth.

Messrs. George Newnes, Ltd., will issue:—"The Story of Life in the Seas," by Prof. Sydney J. Hickson, F.R.S., illustrated; "The Story of Photography," by Alfred T. Story; "The Story of Geographical Discovery," by Joseph Jacobs, with maps.

Mr. J. C. Nimmo announces the completion, in parts, of Morris's Works on Natural History.

Messrs. C. Arthur Pearson, Ltd., give notice of:—"Exercise for Health, its Science and Practice," by H. H. Hulbert; "With Peary near the Pole," by E. Astrup.

Mr. Young J. Pentland's list is as follows:—"Diseases of the Heart," by Dr. G. A. Gibson; "Text-book of Medicine," by British authors, edited by Dr. G. A. Gibson; "The Principles of Treatment," by Dr. J. Mitchell Bruce; "Text-book of Physiology," edited by Prof. E. A. Schäfer, F.R.S., vol. ii.; "Renal Growths," by Dr. T. N. Kelynack; "Diabetes Mellitus," by Dr. R. T. Williamson; and a new edition of "Handbook of Obstetric Nursing," by Drs. F. W. N. Haultain and J. Haig Ferguson.

In the announcements of Messrs. Swan Sonnenschein and Co., Ltd., we find:—"The Wonderful Century: its Successes and its Failures," by Dr. Alfred Russel Wallace, F.R.S.; "Aristotle's Psychology," including the Parva Naturalia, translated and edited with commentary and introduction by Prof. William A. Hammond; "Ethics," by Prof. W. Wundt, translated with the author's permission from the second German edition by Prof. E. B. Titchener, vol. iii. "The Principles of Morality and the Sphere of their Validity"; "Physiological Psychology," by Prof. W. Wundt, translated by Prof. E. B. Titchener, two vols., illustrated; "History of Contemporary Philosophy," by Prof. Friedrich Ueberweg, edited by Prof. Max Heinze, translated by Prof. W. A. Hammond (forming a supplement to Erdmann's "History of Philosophy," three vols.); "Student's Text-book of Zoology," by Adam Sedgwick, F.R.S., vol. i. Protozoa to Polyzoa (inclusive), illustrated; "Text-book of Palæontology for Zoological Students," by Theodore T. Groom, illustrated; "Text-book of Embryology: Invertebrates," by Profs. Korschelt and Heider, vol. ii. "Crustacea and Arachnoids," translated by Mrs. Bernard, illustrated; "Practical Plant Physiology," by Prof. W. Detmer, translated by Prof. S. A. Moor; "Elementary Text-book of Botany," based on "A Student's Text-book of Botany," by Prof. Sydney H. Vines, F.R.S., illustrated; "Radiation: an Elementary Treatise on Electro-magnetic Radiation and on Röntgen and Cathode Rays," by H. H. Francis Hyndman, with diagrams; "Pocket Electrical Dictionary: Electrical Words, Terms and Phrases," by Dr. Edwin J. Houston; "Cataphoresis, or Elective Medicamental Diffusion, as applied in Medicine, Surgery and Dentistry," by Dr. William James Morton, illustrated; "Eclipses of the Moon from A.D. 300 to 1900," by Robert Sewell; "Fishes," by the Rev. H. A. Macpherson (Young Collector Series); "Handbook of Grasses," by W. Hutchinson, illustrated (Young Collector Series); "Mammalia," by the Rev. H. A. Macpherson (Young Collector Series); "Birds' Eggs and Nests," by W. C. J. Ruskin Butterfield (Young Collector Series); and a new edition of "Handbook of Practical Botany, for the Botanical Laboratory and Private Student," by Prof. E. Strasburger, edited by Prof. W. Hillhouse, illustrated.

Messrs. Sotheran and Co. will publish, in 12 parts, "A Monograph of the Turdidæ, or Family of Thrushes," by the late Henry Seebohm, illustrated.

Mr. B. G. Teubner (Leipzig) announces:—"Vorlesungen über Geschichte der Mathematik," Moritz Cantor, Dritter (Schlufs-) Band, Dritte Abteilung; "Vorlesungen über Technische Mechanik," A. Föppl, Band III.; "Vorlesungen über Synthetische Geometrie," Jacob Steiner, Zweiter Teil, Dritte Auflage, herausgegeben von Rudolf Sturm; "Das Gesetz der Kleinen Zahlen," Dr. L. von Bortkewitsch; Joh. Kepler's "Weiland Kaiserlichen Mathematikers, Traum oder nachgelassenes Werk über die Astronomie des Mondes," Übersetzt und Kommentiert, Ludwig Günther.

Mr. T. Fisher Unwin promises:—"Through Unknown Tibet," by Captain M. S Wellby, illustrated; "Across the Sub-Arctics of Canada: 3200 miles by Canoe and Snowshoe through the Barren Lands," by J. W. Tyrrell, with list of plants collected *en route*, a vocabulary of Eskimo words and phrases, and a route map and full classified index, illustrated; "British Guiana; or, Work and Wanderings among the Creoles and Coolies, the Africans and Indians of the Wild Country," by the Rev. L. Crookall, illustrated; *Masters of Medicine*—"William Stokes: his Life and Work (1804–1878)," by his son, William Stokes; "Life of Sir Benjamin C. Brodie," by Timothy Holmes.

Messrs. Whittaker and Co.'s announcements are:—"Alternate Currents in Practice," translated from the French of Loppé and Bouquets by F. J. Moffett: "Electrolytic Methods of Analysis," translated and adapted from the German of Dr. B. Neumann by J. B. C. Kershaw; a volume on "Radiography," by S. Bottone; "A Popular Guide to Commercial Telephony," by M. Byng and F. G. Bell; "Alternating Currents of Electricity, and the Theory of Transformers," by Alfred Still; "Electro-Mechanical Series," adapted from the French by A. G. Elliott: vol. i. "Industrial Chemistry"; "A Text-book of Geography," by Charles Bird; "Electric Wiring Switches and Lamps," by W. Perren Maycock; "Electric Wiring and Fitting Details Book," by the same author.

Messrs. J. Wright and Co. (Bristol) will publish:—"Examination of the Ocular Muscles," by Dr. Ernest E. Maddox, illustrated; "Lectures on Massage and Electricity in the Treatment of Disease (Masso-Electrotherapeutics)," by Drs. Thomas Stretch Dowse and Arthur G. Haydon, illustrated; and a new edition of "Diseases of the Upper Respiratory Tract, the Nose, Pharynx, and Larynx," by Dr. P. Watson Williams, illustrated.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Graces for the establishment of Readerships in Surgery and in Geography having passed the Senate, the General Board will proceed to elect the new Readers early in May.

IN the House of Lords on Friday the London University Commission Bill was read a third time and passed.

THE chair of Veterinary Surgery at the Royal Agricultural College, Cirencester, rendered vacant by the recent resignation of Prof. Wilson, has been accepted by Mr. J. W. Brittlebank.

MR. J. MONTGOMERY, B.A., Assistant Master at Parmiter's School, and Honorary Secretary of the Assistant Masters' Association, has been appointed Head Master of Uckfield Grammar School, Sussex.

DR. R. ANSCHÜTZ, assistant professor of chemistry at Bonn, and Dr. Askenasy, assistant professor of botany at Heidelberg, have been promoted to professorships; Dr. W. J. Simpson, late health officer of Calcutta, has been appointed professor of hygiene in King's College, London; and Dr. H. Ebert, of Kiel, has been appointed professor of physics at Munich.

SIR WILLIAM FRASER, formerly Deputy-Keeper of the Records of Scotland, who died on March 13, has by his will left to the University of Edinburgh 25,000*l.* for the foundation of a chair to be called the Sir William Fraser Professorship of Ancient History and Palæography, 10,000*l.* for the purpose of the library, and one half of the residue of his estate, which is expected to amount to between 9,000*l.* and 10,000*l.*, for general requirements, bursaries, research, publications, &c.

THE educational interests of the State of New York are under the general supervision of the Board of Regents of the University, which is appointed by the legislature, and makes an annual report of the general condition of educational institutions throughout the State. It appears from their annual report of the Board, just published, that the first university in the State, in the number of professors and students, and in the amount of endowment, is Columbia University, with 289 instructors and 1921 students in all departments, and an endowment exceeding 17,800,000 dollars in value. Cornell University is a good second in all these particulars; then follow New York University and Syracuse University.

THE Duc de Loubat has given to Columbia University a deed of a large block of buildings on Broadway, New York, valued at more than 1,100,000 dollars, and probably worth fully a million and a quarter. The gift is subject to an annuity of 60,000 dollars to the Duke during his lifetime. Upon his death the property or its proceeds, less any excess of income advanced by the University, is to constitute an endowment fund for the support and maintenance of the University library. The fund will be named, in honour of the Duke's parents, the Gaillard-Loubat Endowment Fund. This gift, added to previous endowments, will make the library one of the world's great libraries. The building is the gift of President Seth Low. It now holds 250,000 volumes, and has accommodation for a million. The

main reading-rooms seat 400 or 500 readers; and the rooms of the Avery Collection and seminary rooms will accommodate several hundred more. The Duc de Loubat has made many other generous gifts to educational institutions, having founded professorships and scholarships in Berlin, Stockholm, Madrid, and the Universities of France and Italy. In America he has given valuable books and manuscripts to the University of Washington, University of Pennsylvania and Columbia; and at Columbia he founded the Loubat prizes of 1000 and 400 dollars, which are given annually for original work in various branches of science and art.

In the House of Commons, on Tuesday, Sir John Lubbock called attention to the new Education Code, and the need of extending its provisions so that elementary science might be more widely taught in elementary schools. He moved: "That it is desirable to assimilate the provisions of the English Education Code, as regards class and special subjects, to those in the Scotch Code of 1897." Under the Code the subjects taught in elementary schools fall into three categories—the obligatory subjects, the class subjects, and the so-called specific subjects. The obligatory subjects are, in the case of boys, reading, writing, and arithmetic. The specific subjects comprise various sciences, domestic economy, and one or two languages. With the exception of domestic economy, however, they are not largely taken up. The class subjects are English, geography, elementary science, and history. Sir John Lubbock submitted that all these four subjects are essential. He did not propose to make them obligatory, but thought schools should be encouraged to take them up. So far from this, however, schools are actually precluded from doing so. The Code provides that no child shall be presented in more than two class subjects. If, therefore, a class took geography and elementary science, they must omit history and English. If they took history and English, then elementary science and geography must be omitted. Sir John Lubbock's contention was that this is a radically wrong system of education; that English, geography, elementary science, and history are all important subjects; and that the influence of the Education Department should be exercised not to prevent, but to encourage these being taken up in elementary schools. After a discussion, in the course of which it was pointed out that the whole difficulty is one of time, Sir John Lubbock withdrew his motion.

SCIENTIFIC SERIALS.

American Journal of Science, March.—Geothermal data from deep artesian wells in the Dakotas, by N. H. Darton. Nearly all the waters in the great artesian basin of the Dakotas are perceptibly warm. The author gives a chart showing the distribution of the wells according to temperature, which shows remarkable regional regularities. As regards the cause of the subterranean heat, the suggestion as to the oxidation of pyrites by underground waters is probably untenable on account of the depth. A collection of all available data will be necessary before a theory is attempted.—Examination of some triclinic minerals by means of etching figures, by T. L. Walker. Experiments may be made with etching figures to determine the equivalence of pairs of parallel faces. If parallel faces give different etching figures, the faces do not belong to the same crystal form. This thesis was proved by etching tourmaline with a red-hot mixture of potassium bisulphate and powdered fluorspar, and by etching axinite, cyanite, albite, and other crystals.—Some new Jurassic vertebrates from Wyoming, by W. C. Knight. The new species are called *Ceratodus robustus* and *Ceratodus americanus*.—Auriferous conglomerate of the Transvaal, by G. F. Becker. The workable area of the Witwatersrand is a strip of country a couple of miles in width and about thirty miles in length. The banket skirts the southerly edge of a large area dotted over with proclaimed gold-fields, in which ordinary veins are associated for the most part with crystalline schists. This area includes the northern part of the Transvaal and portions of Mashonaland and Matabeleland. Its extent is approximately 130,000 square miles. The banket is a highly siliceous mass, consisting of quartz pebbles embedded in a matrix composed of sand, pyrite, and other minerals, all cemented by secondary silica. The free gold in the matrix, like the pyrite, occurs in minute crystals or in irregular, sharp-cornered, hackly aggregates. The author inclines to the marine placer origin of the deposit, and believes that until the Lower Cape formation has been traced across the continent of Africa other spots as rich as the Rand may be hoped for.—A spectroscope without prisms or gratings, by A. A. Michelson. A kind of transmission grating may be made of plates of glass a few mm. thick, arranged with their edges in a step-by-step order. The results are comparable with those of the best gratings.

Annalen der Physik und Chemie, No. 1.—Canal rays, by E. Goldstein. The canal rays are so called from the manner of obtaining them by perforating the kathode. They form the yellow layer next the kathode, and when the latter is perforated straight yellow streamers pass through and fill the tube on the side away from the anode. These rays produce no phosphorescence, and are not in themselves deflected by a magnet. They form the prolongation of the kathode rays backwards, and converge when the latter diverge, and *vice versâ*.—Potential gradients in vacuum tubes, by W. P. Graham. The gradient along the tube was investigated chiefly by means of two electrodes mounted on a glass rod a small fixed distance apart. The glass rod was introduced into the tube through the Torricellian mercury column, and could be moved up and down. Maximum and mininum gradients were observed to correspond with the bright and dark strata of the positive light. But such fluctuations were also observed in the dark space itself. Minimum gradients were found to adjoin the two electrodes.—Coloured alkaline haloids, by E. Wiedemann and G. C. Schmidt. The authors endeavour to discriminate between the various theories advanced in explanation of the coloration of alkaline haloids by the kathode rays, and show that it is due not to a physical change, but a slight chemical reduction of the salts.—Determination of relative thermal conductivities by the isothermal method, by W. Voigt. The method devised by de Sénarmont for the investigation of crystalline conductivities may be considerably improved by adding elaidinic acid to the mixture of wax and turpentine. This gives very sharp curves. The method may be extended to the comparison of conductivities of various metals by constructing a rectangle out of two adjacent triangles of the metals in question, and pressing the shorter edge of the better conducting metal against a copper block kept at a constant temperature. The method admits of an accuracy of 2 per cent.—The optical constants of sodium, by P. Drude. The refractive index of sodium, as determined from the reflective properties of the metal contained in a spherical vessel in an atmosphere of hydrogen, is smaller than 0·054, which is the smallest value yet found for any metal. The standard NaK alloy comes next; and then silver with $n = 0·18$.—Glow-worm light, by H. Muraoka and M. Kasuya. Further experiments show that the photographic effect of glow-worm light is not due entirely to radiation, but partly at least to volatile substances inseparable from animal life. Resin and coffee, and certain metallic oxides, produce a similar effect, even when not in contact with the plate.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 17.—"On the Connection between the Electrical Properties and the Chemical Composition of different kinds of glass." By Prof. Andrew Gray, LL.D., F.R.S., and Prof. J. J. Dobbie, M.A., D.Sc.

In order to finally determine if possible the circumstances which affect the conductivity and specific inductive capacity of glass, several specimens of glass of special composition have been made up for the experimenters by Messrs. Schott and Co., of Jena, and by Messrs. Powell and Sons, of London. It had been previously found, by Prof. T. Gray, that potash and soda lime glasses had a higher conductivity than flint glasses—a result also arrived at by Dr. Hopkinson. Accordingly glasses richer in lead oxide than any formerly available, and in some cases practically free from soda, were made, so as to test whether diminution of the amount of soda and increase of lead oxide would still further diminish the conductivity. Specimens of glass used by Messrs. Schott, mainly in the manufacture of thermometers, were also obtained, as well as of a barium crown glass, not hitherto experimented on.

The conductivities were measured by the direct deflection method by placing the specimen (in some cases the bulb of a long-stemmed flask, filled up to the bottom of the stem with mercury, and immersed in a mercury bath; in others a plate silvered on its two faces) in series with a battery and a very sensitive high resistance galvanometer. The method of loss of

charge was tried, but found for various reasons to be less suitable for the comparison immediately in view than that adopted. It is, however, the only method by which, for several of the specimens, results at ordinary temperatures can be obtained. Special care was taken to ensure that no disturbing film of moisture existed on the surface of the glass, and that the conduction was entirely through the plate or the walls of the flask experimented on.

The specific inductive capacities were determined by connecting the condenser formed by the specimen, for about 1/30,000 of a second, with one of Lord Kelvin's air leydens, which had been previously charged, and observing the potential of the leyden before and after the contact.

After the electrical determinations had been made the specimens were very carefully analysed, and the results are given in the paper, which contains, therefore, full information as to the precise composition of the glasses.

The anticipation mentioned above was fully borne out. The specific resistance of the lead potash glasses was for one certainly above $18,000 \times 10^{10}$ ohms at 100° C., for another above $35,000 \times 10^{10}$ ohms at all temperatures up to 135° C. The specific resistance of the barium glass was also very high; and, what was remarkable in this glass, there was hardly any trace of dielectric polarisation. The authors are pursuing experiments on the electrical and mechanical properties of this glass.

It was found, after the communication of the paper, that the almost complete replacement of the potash in a lead glass by soda diminishes the specific resistance.

The research is being continued with a view to settling a large number of interesting points which have arisen in the course of the work. For this purpose special glasses of as nearly as possible prescribed composition are being made by Messrs. Powell and Sons.

March 3.—"On Apogamy and the Development of Sporangia upon Fern Prothalli." By William H. Lang, M.B., B.Sc.

In this paper the results obtained from a series of cultures of ten species of ferns, the prothalli of which were grown for more than two years, are described. The conditions of cultivation differed from those under which prothalli usually occur in nature, in that fertilisation was prevented by avoiding watering from above; the prothalli were also exposed to direct sunlight. To these causes the results, which in the main agree for the various species, may be ascribed. The most important were the change in form and structure of the prothallus to a fleshy cylindrical process, which sometimes proceeded from the apical region, sometimes from the under surface just behind the latter; the development of conical projections around or in place of archegonia, and the occurrence of more or less numerous cases of apogamy in every one of the species. The latter phenomenon was manifested by the presence of tracheides in the tissue of the prothallus, by the development of isolated members of the sporophyte upon it, and, in every case but one, of complete vegetative buds. On prothalli of *Scolopendrium vulgare* and *Nephrodium dilatatum* sporangia, which sometimes attained almost perfect development, were found. In conclusion the bearing of the results on the nature of the alternation of generations seen in archegoniate plants is considered, and a provisional hypothesis is suggested to explain how the definite alternation of sexual and asexual forms might have originated by modification of individuals of the ancestral algal organisms under the conditions to which they would presumably have been exposed on their assumption of a terrestial mode of life.

"Experimental Observations on the early Degenerative Changes in the Sensory End Organs of Muscles." By F. E. Batten, M.D. Communicated by Prof. Victor Horsley, F.R.S.

The experiments described in the following paper were undertaken in order to show, firstly, that degeneration occurred in the first place in that part of the neuron most remote from the cell, and secondly, to reproduce within the muscle-spindle, if possible, certain changes which had been shown by the author to be present in the case of tabes dorsalis in man.

The results of the research have been to show:

(1) That within the muscle-spindle a spiral form of nerve termination exists surrounding a fine muscular fibre, in the centre of which are large, clear, non-nucleated cells.

(2) That changes take place in the spiral in twenty-four hours after section of the nerve, and that such changes become marked in forty-eight hours.

(3) That degeneration of the medullated sheath of the nerve takes place in the whole course of the nerve at the same time after section of the nerve.

(4) That no fatty change could be demonstrated in the intramuscular cells by the Marchi method similar to those found in the case of tabes dorsalis in man.

Entomological Society, March 2.—Mr. G. H. Verrall, Vice-President, in the chair.—Lord Walsingham exhibited a series of the larger and more striking species of Xyloryctinæ, a subfamily of the Gelechiidæ, especially characteristic of the Australian fauna. The series illustrated the life-histories and the great disparity in colour and form between the sexes of many species. He also gave an account of the family, chiefly from notes by Mr. Dodd (of Queensland), with especial reference to the habits of the larvæ, which live in holes in tree-trunks, to which they drag leaves in the night for the next day's consumption.—Mr. Gahan exhibited a locust, *Acrydium ægyptium* (= *tartaricum*), taken in a house in Hanover Square, and probably imported in vegetables.—Mr. Kirkaldy exhibited species of water-bugs, including *Enicocephalus culicis* and *Gerris robustus*, both taken for the first time in Mexico.—A discussion arose on the reported occurrence of the San José scale, *Aspidiotus perniciosus*, in Great Britain.

Linnean Society, March 3.—Dr. St. George Mivart, F.R.S., Vice-President, in the chair.—Mr. Thomas Christy exhibited specimens of the Mora Nut of British Guiana (*Dimorphandra Mora*, Schomb.), of which some had been lately introduced into London by Colonial brokers as the Kola Nut (*Cola acuminata*). It appeared, however, on analysis, that the former contains no caffeine, a product for which the latter is of definite commercial value. It remained to be ascertained whether the Mora Nut has any economic value.—Prof. W. A. Herdman, F.R.S., read a paper by Mr. F. J. Cole, entitled "Observations on the structure and Morphology of the cranial nerves and lateral sense organs of fishes, with especial reference to the genus *Gadus*." It contains the first description of the lateral-line organs of *Gadus*, and pit-organs were shown to be present. The author concludes that the lateral-line system of fishes was not originally metameric, and that it has nothing to do with the branchial sense-organs. He regards it and the auditory organ as parts of a system, and their nerves (viz. the superficial ophthalmic, buccal, external mandibular, lateralis, and lateral-line nerves), together with the auditory, as of a series *sui generis*, and shows that the so called lateral-line nerve of *Petromyzon* really belongs to the lateralis accessorius system (ramus lateralis trigemini, auct.), the morphology of which he fully describes. The paper deals exhaustively both with the afore-mentioned and the subsidiary branches of the subject, which is treated in detail and historically, with an accompanying exhaustive bibliography.—Prof. Howes, discussing the paper at some length, drew attention to some observations of the Cousins Sarasin, and to the experimental work of Sewall, Steiner, Lee and others upon the auditory apparatus of fishes. which he believed lent support to the author's conclusions.—Mr. G. Claridge Druce read a paper on the occurrence of *Carex helvola*, Blytt, in Britain, in which he gave an account of his discovery of this plant on Ben Lawers, Perthshire, in August 1897. He found it growing in some abundance at an elevation of about 3200 feet. Prof. Blytt and Dr. Christ, to whom specimens had been submitted, both agreed in naming it *C. helvola*, which by many botanists is considered to be a hybrid.—A report by the Rev. O. P. Cambridge, F.R.S., upon the spiders collected by Mr. Fisher, of the Jackson-Harmsworth Polar Expedition, was read by Mr. A. D. Michael. They consisted of three species, all belonging to the genus *Erigone*, one of which had been previously described, though not figured by Thorell; and another was new, but closely allied: the author proposes to call the latter *E. Fisheri*.

Geological Society, March 9.—W. Whitaker, F.R.S. President, in the chair.—Prof. J. W. Judd exhibited, on behal of the Coral Reef Committee of the Royal Society, the lowest core (698 feet) from the boring at Funafuti (Ellice Island), and drew attention to the remarkable changes exhibited by the rocks obtained at this depth. The core from this boring (a mass of material more than a ton in weight) had been sent to this country by Prof. Edgeworth David, and was now being submitted to careful study. The last 20 or 30 feet of the boring was carried on in a rock which was of a very soft character, and highly but minutely crystalline. Microscopic examination shows that the

rock is almost completely converted into a mass of very small rhombohedra, the organic structures being nearly obliterated; while a preliminary chemical examination seems to indicate that magnesia has been introduced into the rock to a considerable extent. The complete study, microscopical and chemical, of all the stages of the change which has taken place in this rock—a study which will be undertaken by Mr. C. G. Cullis—promises to throw much light on processes of rock-formation of very great interest to the geologist.—Note on Clipperton atoll, by Rear-Admiral Sir W. J. Wharton, K.C.B., F.R.S. This atoll, 600 miles from North America, in lat. 10° 17′ N., long. 109° 13′ W., possesses a lagoon which is now completely cut off from the sea. In this is a perfectly round hole where soundings of 20 fathoms or more are reported, on the authority of Mr. Arundel, and even deeper ones on that of the captain of a merchant-vessel. On the coral ring there rises a mass of modified trachyte, the subject of the following communication, about 60 feet in height. The great depth of the lagoon and the rock-mass on the ring are not compatible with the origin of the reef by subsidence or outward growth; and the possible hypothesis is put forth that this reef had grown on the lip of a volcanic crater, or on an island, such as Krakatao, in which the interior has been enlarged and deepened by volcanic explosion.—A phosphatised trachyte from Clipperton atoll, by J. J. H. Teall, F.R.S. Specimens from the projecting rock described in the preceding communication are dark brown, white, or cream-coloured. The brown specimens are trachytes, composed of glassy phenocrysts of sanidine set in a groundmass of microlitic felspars with brown interstitial matter. The light-coloured rocks are more or less altered trachytes, in some of which the glassy phenocrysts of sanidine may still be recognised. Analyses of several specimens show that the rocks all contain varying amounts of phosphoric acid.—The Pliocene deposits of the East of England, Part i. the Lenham Beds and the Coralline Crag, by F. W. Harmer. From the discussion of lists of fossils, a large number of sections, and a series of borings, the author endeavours to establish a number of propositions with regard to the Lenham Beds, the Coralline Crag, and the Red Crag. His evidence indicates that the Lenham Beds are older, perhaps considerably so, than the Coralline Crag.

Mathematical Society, March 10.—Prof. Elliott, F.R.S. President, in the chair.—Mr. A. N. Whitehead read a paper on the geodesic geometry of surfaces in non-Euclidean space.—Prof. W. Burnside followed with a paper on linear homogeneous continuous groups whose operations are permutable.—Mr. T. I. Dewar, in the absence of Prof. Greenhill, F.R.S., exhibited, with the aid of stereoscopes, some stereoscopic diagrams of pseudo-elliptic catenaries and geodesics.—Lieut.-Colonel Cunningham, R.E., contributed a supplementary note on Aurifeuillians.—The President briefly brought before the meeting a paper, by Mr. W. F. Sheppard, on the calculation of the sum of the *m*th powers of a large number of magnitudes, and then (Lieut.-Colonel Cunningham in the chair) read a paper by himself, on the transformation of linear partial differential operators by extended linear continuous groups.

Zoological Society, March 15.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—A communication from Sir Edmund Loder, Bart., contained copies of some photographs of the Beaver-pond at Leonardslea, Horsham, and gave a short account of the habits of the animals as there observed.—Mr. R. E. Holding exhibited a pair of horns of the Sunga or Galla Ox of Abyssinia, and made some remarks on the horns of this and other varieties of the humped cattle of India and Africa.—A communication from Dr. G. Stewardson Brady, F.R.S., on new or imperfectly-known species of Ostracoda, chiefly from New Zealand, was read. It contained descriptions of the Ostracoda collected in New Zealand by Mr. H. Suter, for the Zoological Museum of Copenhagen, and by Mr. G. M. Thomson, of Dunedin. It also included a description of an Ostracod from the Bay of Bengal, presenting some remarkable peculiarities of the mouth-organs, and constituting the type of a new genus, which was proposed to be called *Eupathistonia*. Of the New Zealand species treated of sixteen were described as new, and the new generic term *Trachyleberis* was proposed for the reception of *Cythere scabrocuneata*, Brady.—Mr. E. H. J. Schuster described a new species of flagellate Protozoan, which he proposed to name *Lophomonas sulcata*. This species occurred as an endo-parasite in the upper part of the colon of *Blatta americana*, Linn.—Mr. J. T. Cunningham read a paper on the early post-larval stages of the Common Crab (*Cancer pagurus*), and pointed out the affinity of that species with the Circular Crab (*Atelecyclus heterodon*).—Mr. Oldfield Thomas read a paper on some mammals collected by the late Mr. Henry Durnford in 1877–8 in Chubut, Patagonia.—Mr. Martin Jacoby contributed an addition to our knowledge of the phytophagous Coleoptera of Africa by describing forty-three new species of the groups *Halticinæ* and *Galerucinæ*, specimens of which had been collected by Mr. Guy A. K. Marshall in Mashonaland and West Africa. Two new genera, viz. *Cheiridisia* and *Pseudedusia*, were characterised.

Royal Meteorological Society, March 16.—Mr. F. C. Bayard, President, in the chair.—A lecture on photographing meteorological phenomena was delivered by Mr. A. W. Clayden, who gave details of his experiences as Secretary of a Committee of the British Association. After referring to the extreme value of photographic methods of recording the movements of instruments, the lecturer spoke of the real importance of preserving photographic records of all sorts of unusual meteorological phenomena, and emphasised the necessity of companion photographs showing the same scene under normal conditions. It was suggested that meteorologists throughout the country should co-operate with the Royal Meteorological Society in securing such records. The phenomena of the lightning discharge, as distinguished from those of a single flash, were next described and illustrated by a number of lantern slides. Some of the puzzles offered by lightning photographs were next alluded to, and the lecturer stated that he had repeatedly found that a single discharge lasted several seconds. Mr. Clayden then spoke of the "black" flashes shown in photographs, and described the steps by which, some years ago, he was led to the proof that they were merely a photographic phenomenon, but one which still remains unexplained. Passing on to a consideration of cloud photography, the various methods in use were explained and a large number of lantern slides were exhibited, in some of which the clouds were shown on a background of blue sky in nearly their natural colours, a result obtained by the employment of suitable developers on a specially prepared plate. The method employed at Exeter by the lecturer for the measurement of cloud altitudes was fully described. This differs from all other methods in using the sun as a reference point. Mr. Clayden then spoke of the difficulty in getting good pictures of cirrus clouds, and described the methods dependent on the polarisation of the blue light of the sky, but expressed a conviction that polarisation had nothing to do with their efficiency, which was really due to a general lessening of brightness which enabled the exposure to be properly judged.

CAMBRIDGE.

Philosophical Society, February 7.—Prof. Newton, Vice-President, in the chair.—"The coral reefs of Funafuti, Rotuma, and Fiji, together with some notes on the structure and formation of coral reefs in general," J. Stanley Gardiner. The author had accompanied Prof. Sollas' expedition to Funafuti in 1896. Funafuti cannot be regarded as a typical atoll, as it shows an elevation of at least 10 feet. Its islands are the remains of the original reef, and are rapidly being washed away; while the present reef is extending outwards by nullipore growth, forming masses outside and joining them on to the *rim*. In Viti Levu, Fiji, soft limestone attains an elevation of 900 feet and alternates with "soapstone," which the author regards as a shallow water deposit analogous to the sand covering the inner reefs round Viti Levu. Many of the islands of Lau are of hard limestone, and represent raised atolls. In the case of Vatu Vara a vertical thickness of 1030 is attained. Evidence is given to show that the Fiji Group has been stationary for a long period, and that the conditions and formation of its reefs strongly oppose the subsidence theory. It is also contended that reefs spread outwards on their own talus, while lagoons are formed by solution. Evidence for the latter is given from the washing away of the limestone islands of Lau, the atoll-reefs of which are considered to have been formed by this means. The formation of coral reefs is due rather to nullipore than coral growth, and depends largely on the depth to which light can penetrate sea water.—"Methods for the demonstration of 'connecting threads' in the cell-wall," Walter Gardiner. The author gives further details of his "Kolossow-Safranin" method, and describes a modification of Meyer's method, which he calls the "iodine-acid violet" method. The paper also deals with the theory of both of the above modes of investigation.

February 21.—Mr. F. Darwin in the chair.—On some differential equations in the theory of symmetric algebra, Prof. Forsyth.—Discharge of electrification by ultra-violet light, E. Rutherford. In this paper the general phenomena of conduction under ultra-violet light were considered, especially from the point of view of the nature and velocity of the carrier of the negative electrification. By directing a blast of air against a plate on which ultra-violet light fell, it was shown that the whole or portion of the carriers could be removed with the current of air. The charged gas so obtained shows properties similar to the charged gas obtained in Röntgen conduction. A general method of determining the velocity of the carrier was given. By its means the velocity of the carrier for air was found to be about 1·4 cms per sec. for a potential gradient of one volt per cm. The velocity of the carrier is independent of the metal on which the light falls, but depends on the gas surrounding the plates. The velocity of the carrier was found to be inversely proportional to the pressure, a result which shows the carrier is of molecular dimensions. The results of the experiments are simply explained on the hypothesis that gaseous ions are produced at the surface of the negatively electrified plate. The theory previously advanced that the discharge was due to the disintegration of metallic particles under the action of ultra-violet light does not sufficiently explain the facts.—Röntgen photographs of metallic alloys, C. T. Heycock and F. H. Neville. The authors exhibited and described photographs taken by means of the Röntgen rays through plates of alloy. As the two metals forming the alloy possess different degrees of transparency to these rays, the photographs show the separation of the metals that has taken place during the solidification of the alloy. For example, alloys of gold and sodium containing less than 30 per cent. of gold are seen to consist of well-developed, very transparent crystals, which must be pure, or nearly pure, sodium, imbedded in a mother substance which solidified last, and which, from its comparative opacity, evidently contains the gold. On the other hand, alloys containing more gold show very opaque needles of gold imbedded in a less opaque mother substance. This mother substance was the same as that in the first-mentioned alloy; it solidified after the needles of gold had been formed. Photographs of alloys of aluminium and gold, and of aluminium and copper, were shown, which exhibited similar phenomena. The crystals of aluminium in the alloy with copper were perfect rectangular crosses several millimetres in diameter. The gold-aluminium alloys showed a precipitate of Roberts-Austen's compound of the formula $AuAl_2$; the crystals were well-marked tubes and octahedra.

MANCHESTER.

Literary and Philosophical Society, March 8.—Mr. J. Cosmo Melvill, President, in the chair.—The President announced that the title of the Wilde Lecture to be delivered by Prof. Michael Foster on March 29, would be "On the physical meaning of psychical events."—Mr. Thomas Thorp exhibited some celluloid films taken from Rowland's gratings of 14,438 lines to the inch.—"On the velocity of sound in a tube, as affected by the elasticity of the walls," by Prof. H. Lamb, F.R.S. The paper consisted in an application of the known theory of the vibrations of thin cylindrical shells to the calculation of the velocity of sound in a tube filled with liquid. This subject has already been treated by Korteweg, but the author's method is somewhat different, and one or two collateral results of interest are obtained. The paper included, further, an approximate investigation of the effect in a *thick* tube.

EDINBURGH.

Royal Society, January 31.—Prof. Chrystal in the chair.—An obituary notice of the late Edmund Chisholm Batten was read.—Dr. J. K. Talmage, a delegate to the Geological Congress of 1897, gave in a report of the meetings.—Papers by Dr. Thomas Muir, on the relations between the co-axial minors of a determinant of the fourth order, and by Prof. Nanson on the Ellipse-Glissette elimination problem, being purely technical, were laid on the table.—Mr. W. L. Calderwood read a paper on the migratory movements of Salmonidæ during the spawning season. After distinguishing between spring and summer runs of fish and calling attention to the dissimilarity between such runs and the autumn runs to the head waters for the express purpose of spawning, the author showed that these last runs could alone be considered as analogous to the runs in connection with the spawning habit of *Clupea allosa*, *C. finta*, or *Petromyzon marinus*. As to the conditions of water flow which seemed most favourable for Salmonidæ entering a tributary from a main river, Mr. Calderwood submitted several tables of data collected by daily observations in the spawning season of 1896-97. The results showed that most fish entered the particular tributary under consideration when the water was in quarter-flood; that temperature had apparently no influence upon the runs of fish; that a limited number of fish ascended during normal flow of the stream; that the sea trout commenced to ascend later than salmon, but remained a much shorter period, completing their spawning two months before the last salmon redd was observed. The author exhibited a diagram-chart of the spawning grounds, showing the distribution of salmon and sea trout redds, and the dates on which the redds were constructed.

PARIS.

Academy of Sciences, March 14.—M. Wolf in the chair.—Chemical actions of the silent discharge. Nitrogen compounds in presence of free nitrogen, by M. Berthelot. A continuation of similar work published in preceding numbers of the *Comptes rendus*. The substances dealt with included methylamine, dimethylamine, ethylamine, propylamine, isopropylamine, allylamine, aniline, methylaniline, benzylamine, toluidine, pyridine, piperidine, ethylenediamine, propylenediamine, phenylenediamine, benzidine, nicotine, acetamide, thiourea, acetonitrile, benzonitrile, aldoxime, phenylhydrazine, some nitro-derivatives, pyrol and indol.—On the estimation of carbon monoxide diluted with large quantities of air, by M. Armand Gautier. Remarks on the use of iodic anhydride for the estimation of minute quantities of carbonic oxide (1 in 20,000). The reaction is complete at 60°, the iodine being collected upon a roll of reduced copper and weighed. Better results are obtained by determining the carbon dioxide produced. Acetylene also reacts with iodic anhydride, and ethylene, although not reacting itself at 60°, possesses the peculiar property of completely preventing the oxidation of carbon monoxide.—On the importance of sugar considered as a food; new demonstration of the superior nutritive value of sugar compared with that of fat, taking the respective thermogenic values of the two foods into account, by M. A. Chauveau. Two series of experiments were carried out upon the same animal (a dog), one with a sugar and the other with a fatty diet; the results showed that sugar possesses great advantage over the dynamically equivalent proportion of fat. It is, then, erroneous to consider the nutritive value of a food as measured by its heat of combustion.—The development of the sponges, by M. Edmond Perrier. A controversial reply to a paper on the same subject by M. Yves Delage.—The expedition to Greenland of the Geographical Society of Berlin, by M. Marcel Bertrand. The present note deals only with that part of the work which concerns the structure of the ice and the movements of glaciers. The explanation given for the latter, which satisfactorily accounts for all the observed facts, is practically identical with that proposed by Thomsen, the arguments now added by M. de Drylgaski rendering these views more precise.—On the theory of numbers, by M. H. Laurent.—Integral invariants and optics, by M. Hadamard.—On the laws of reciprocity, by M. X. Stouff.—On the transformation of Abelian functions, by M. G. Humbert.—The energy of an electrified system, considered as distributed in the dielectric, by MM. H. Pellat and P. Sacerdote.—On the electric conductivity of thin plates of silver, by M. G. Vincent. The films were deposited on glass, and the thickness, which varied between 38μ and 170μ, measured by the methods of Wiener and Fizeau. The results of the measurements fell practically upon a straight line for thicknesses down to 50μ, below which an inflexion of the line took place. This critical thickness agrees well with the number obtained by Quincke in his capillarity experiments.—Some properties of electric discharges produced in a magnetic field. Assimilation to the Zeeman phenomenon, by M. André Broca. The hypothesis of the existence of ions in incandescent gases is sufficient to coordinate all known facts relating to the radiation of incandescent gases and also those relating to the electric discharge in gaseous media.—On the barometric formula, by M. Alfred Angot. The assumptions necessary for the accuracy of the Laplace formula are not strictly fulfilled in actual practice, so that the heights of an experimental balloon determined by the barometer and by triangulation respectively, may differ by as much as 500 metres in a height of 11,000 metres.—On the

characters of the seasons of successive years, by M. P. Garrigou-Lagrange.—On the causes of the reciprocal replacement of two acids, by M. Albert Colson. An experimental study of the action of hydrogen sulphide upon the dry silver salts of orthophosphoric and pyrophosphoric acids.—On a new silicide of chromium, by M. Ch. Zettel. This silicide has the composition $SiCr_3$, and is obtained by strongly igniting in a Perrot gas furnace a mixture of copper, aluminium and chromic oxide. It is a well crystallised, very stable substance, which resists the action of all acids except hydrofluoric.—On a new method of fractionating the yttrium earths, by M. G. Urbain. The method consists of the fractional crystallisation of the ethyl sulphates. The results are similar to those obtained by the use of the acetylacetonates, the sulphates, and by the fusion of the nitrates.—On two modes of decomposition of some thiocyanic ethers, by M. Œschner de Coninck.—On some oxyethers of β-naphthol, by M. F. Bodroux. The ethyl, propyl, isopropyl, isobutyl, and isoamyl ethers are described.—On the product of oxidation of glycerine by the bacterium of sorbose, by M. Gabriel Bertrand. Dioxyacetone, $CH_2OH.CO.CH_2OH$, is the chief product; it was identified by means of its oxime.—On the sterilisation of liquids by filtration, by M. J. Hausser. Infusorial earth, calcined at 800° to 1000° C., powdered, and made into an emulsion with water deposits on any suitable filter support as a fine compact layer, which is capable of retaining the most minute suspended particles or micro-organisms. A thickness of ·4 to ·5 mm. is sufficient for sterilisation, and the velocity of filtration may be many times greater than with Chamberland filters.—The different modes of eliminating lime in rickets at different stages of the disease, by M. J. Babeau.—Embryogeny of the double larva of the Diplosomidæ, by M. Antoine Pizon. The results of Salensky concerning the development of the branchio intestinal apparatus are confirmed, and in addition the function of the epicardial tubes is established.—On the splitting of the cuticle, by M. P. Pautel.—The culture of *Tricholoma nudum*, by MM. J. Constantin and L. Matruchot.—Action of different salts upon the structure of plants, by M. Charles Dassonville. The structure of true plants varies greatly according to the chemical composition of the medium in which they grow, those solutions which are most favourable to the development of the plant being also those which produce in it the greatest differentiation.—On a new generic type of Schizomycetes, the *Chatinella*, by M. E. Roze.

DIARY OF SOCIETIES.

THURSDAY, March 24.

Royal Society, at 4.30.—The Bakerian Lecture will be delivered by Dr. W. J. Russell, F.R.S. Subject: Further Experiments on the Action exerted by certain Metals and other Bodies on a Photographic Plate.

Royal Institution, at 3.—Recent Researches in Electricity and Magnetism: Prof. J. A. Fleming, F.R.S.

Institution of Electrical Engineers, at 8.—Cost of Generation and Distribution of Electrical Energy: R. Hammond.

Institution of Civil Engineers, at 4.—Prof. Boyd Dawkins will repeat the Sixth "James Forrest" Lecture on Geology in Relation to Engineering.

Camera Club, at 8.15.—Photographic Engraving in Intaglio: Colonel Waterhouse.

FRIDAY, March 25.

Physical Society, at 5.—On the Circulation of the Residual Gaseous Matter in a Crookes' Tube: A. A. Campbell Swinton.—On some Improvements in the Roberts-Austen Recording Pyrometer, and Notes on Thermo-electric Pyrometers: A. Stansfield.

Institution of Civil Engineers, at 8.—Internal Governor Friction H. O. Eurich.

MONDAY, March 28.

Society of Arts, at 8.—The Thermo-Chemistry of the Bessemer Process: Prof. W. N. Hartley, F.R.S.

Royal Geographical Society, at 8.30.—Exploration on and around Mount Aconcagua: E. A. Fitzgerald.

Institute of Actuaries, at 5.30.—Industrial Assurance: C. H. E. Rea.

TUESDAY, March 29.

Royal Institution, at 3.—Simplest Living Things: Prof. E. Ray Lankester, F.R.S.

Institution of Civil Engineers, at 8.—Extraordinary Floods in Southern India: their Causes, and Destructive Effects on Railway Works: E. W. Stoney.

Anthropological Institute, at 8.30.—On the Natives of the Upper Welle District of the Belgian Congo: Captain Guy Burrows. (Illustrated with Lantern Slides and Objects of Ethnological Interest.)

WEDNESDAY, March 30.

Society of Arts, at 8.—Telegraphy across Space: Prof. Silvanus P. Thompson, F.R.S.

THURSDAY, March 31.

Society of Arts (Indian Section), at 4.30.—The Earthquake in Assam: Henry Luttman-Johnson.

Royal Institution, at 3.—Recent Researches in Magnetism and Diamagnetism: Prof. J. A. Fleming, F.R.S.

Chemical Society, at 3.—Annual General Meeting.

Camera Club, at 8.15.—Prof. Joly's System of Colour Photography: Captain Abney, C.B., F.R.S.

FRIDAY, April 1.

Royal Institution, at 9.—Liquid Air as an Analytic Agent: Prof. Dewar, F.R.S.

BOOKS AND SERIALS RECEIVED.

Books.—Results of Rain River, and Evaporation Observations made in New South Wales during 1896: H. C. Russell (Sydney).—The Mines of New South Wales, 1897: C. W. Carpenter (G. Robertson).—Fisiol gia Vegetale: L. Montemartin (Milano, Hoepli).—Anatomia Vegetale. Dr. F. Tognini (Milano, Hoepli).—Navigazione Aerea: G. N. Da Pra (Milano, Hoepli).—Storia Naturale: Dr. A. Griffini (Milano, Hoepli).—Marriage Customs in many Lands: Rev. H. N. Hutchinson (Seeley).—Canada's Metals: Prof. Roberts-Austen (Macmillan).—Practical Guide to Photography: Marion and Co., 6th edition (Marion).—A New Astronomy: Prof. D. P. Todd (New York, American Book Company).—Théories de L'Electrolyse: A. Minet (Paris, Gauthier-Villars).—Recherches sur les Origines de l'Égypte, Ethnographie Préhistorique et Tombeau Royal de Négadah: J. De Morgan (Paris, Leroux).—Laboratory Experiments on the Class Reactions and Identification of Organic Substances: Drs. Noyes and Mulliken, 2nd edition (Easton, Pa., Chemical Publishing Company).—The Freezing-Point, Boiling-Point, and Conductivity Methods: H. C. Jones (Easton, Pa., Chemical Publishing Company).—An Arithmetic for Schools: S. L. Loney (Macmillan).—Spectrum Analysis: Dr. J. Landauer, translated by Dr. J. B. Tingle (Chapman).—Sitzungsberichte der K.B. Gesellschaft der Wissenschaften, Math.-Naturw Classe 1897, 2 Vols. (Prag).—The Linacre Reports, edited by Prof. E. Ray Lankester, Vol. 3 (Adlard).

Serials.—American Journal of Science, March (New Haven).—Psychological Review, March (Macmillan).—History of Mankind: F. Ratzel, translated, Part 24 (Macmillan).—Zoologist, March (West). Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1898, No. 2 (Bruxelles).—Journal of the Franklin Institute, March (Philadelphia).—Transactions of the Leicester Literary and Philosophical Society, January (Leicester).—Quarterly Journal of the Royal Meteorological Society, January (Stanford).—Bulletin of the Essex Institute, July–December, 1896 (Salem).—Board of Trade Journal, March (Eyre).—Timehri, December (Stanford).—Among British Birds in their Nesting Haunts: O. A. J. Lee. Part x. (Edinburgh, Douglas).—Proceedings of the Society for Psychical Research, February (Paul).—Wide World Magazine, April (Newnes).—Archives of the Roentgen Ray, February (Rebman).—Transactions of the Institution of Engineers and Shipbuilders in Scotland, March (Glasgow).—Morphologisches Jahrbuch, 25 Band, 4 Heft (Leipzig).

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THURSDAY, MARCH 31, 1898.

CÆNOGENESIS, THE EXPRESSION OF VARIOUS PHYLOGENETIC ENERGIES.

Kainogenesis als Ausdruck differenter phylogenetischer Energien. Von Dr. Ernst Mehnert, Privat-docent an der Universität Strassburg i. Elsass. Pp. 165, and plates. (Jena: Gustav Fischer, 1897.)

IT has become more and more evident, during the past twenty years, that the course of ontogeny may vary in a quite remarkable degree, even within the limits of a genus, and that the individuals of a species may present not unimportant differences in their respective ontogenies. This contradiction of the old-established belief that the type of development was similar for every considerable group of animals, has led to the abandonment of many of the older principles of embryology, and has introduced no small amount of confusion into embryological speculations. The question which confronts the investigator is this: which among the several modes of development which occur in closely allied species is to be regarded as primitive, and which secondary? In other words, what developmental features are palingenetic and what cænogenetic?

In the present work Dr. Mehnert seeks an answer to the question by a comparison of the developmental characters exhibited in homologous organs in individual embryos and in individual species with the characters exhibited by the same organs in adult individuals.

The definitive condition of an organ in an adult individual is, he says, the direct product of its phylogeny: it is therefore possible, by means of such a comparison, to recognise the characteristic correlative differences which obtain between the several ontogenies of homodynamous organs and their different degrees of phyletic perfection. He proposes to establish the principle that the law of close interdependence between phylogeny and ontogeny leads, as a consequence, to the appearance of cænogenesis; in other words, that cænogenesis is not, as is often assumed, an anomalous phenomenon, but is governed by strictly regulated principles.

In order to establish his thesis, Dr. Mehnert gives the results of his extensive researches on the fore and hind limbs of pentadactyle Vertebrates. He selected these as most appropriate to his purpose because the hand and foot are serially homologous, and because each is an organ composed of several dozen separate but approximate and partly homodynamous skeletal pieces, whose homologies can with some certainty be asserted in the whole group of pentadactyle Vertebrates. The different stages of prechondrified, chondrified, and ossified tissues also afford a series of changes whose estimation presents no difficulty.

Although he has worked over a great number of species, Dr. Mehnert confines himself to the detailed description of a few forms, selecting *Emys lutaria*, *Struthio*, some carinate birds, some Mammals, and some Amphibia.

The hand of Emys is, as is well known, typical. There are five digits, a distal row of five carpals, a proximal row of three carpals (radiale, intermedium and ulnare) and a centrale. In addition, Dr. Mehnert recognises certain "sesamoid" bones, an ulnare externum, a radiale externum, a centrale ulnare, and a centrale distale as belonging to a regressive skeletal series which was ancestrally equivalent to the other carpalia. He finds that the pendactyle arrangement is early sketched out in prechondrial tissue, and that chondrification begins in the forearm, and proceeds distally, each transverse row of carpalia, metacarpalia and phalanges chondrifying at the same time, the different rows successively in centrifugal order. This condition is compared to that of the foot of Struthio, which in the adult is two-toed, the third and fourth digits alone being developed. In young embryos, however, the foot is discovered to be pentadactyle; only three toes are visible externally, but in sections all five may be distinguished. The centres of chondrification appear successively, beginning in the proximal elements, and extending at short intervals of time to the distal elements. Of the metatarsalia, the third and fourth, corresponding to the permanent toes of the adult, are the first to be chondrified, the second and fifth are chondrified later; the first, being very rudimentary, disappears early. The conclusion is that in development permanent structures are accelerated, evanescent structures retarded. The same principle is illustrated by the development of the wing, and even more remarkably, for whereas it is usual in Vertebrata that the hind limb should lag behind the fore limb in development, in Struthio, and also in Apteryx, the adult reduction of the fore limb is foreshadowed in the embryo, since it lags behind the hind limb from the first. The same phenomenon is observed in Anura, in the adults of which the hind limbs are predominant as compared with the fore limbs. From a number of considerations, such as the limb of Baptanodon, and the embryonic condition of the limbs of Emys, Mehnert concludes that all the skeletal elements of the limb were primitively of equal size, and somewhat short and square in shape. If this were so, the long bones and the metacarpals, metatarsals and phalanges would be progressive elements, which have increased in length in the course of phylogeny, whilst the carpals or tarsals would be regressive elements, and on his principle the last-named should show evidence of retarded, the former of accelerated development. This he shows to be the case in Mammals and in carinate birds, in which the metacarpal precedes the carpal differentiation. By the comparison of a large number of forms Mehnert arrives at the general rule, that all the permanent digital rays are histologically differentiated at a very early period, and are the first to be divided into their components: in the regressive lateral digits the reverse is the case—they lag far behind the predominant digits, and they may eventually degenerate and disappear.

Mehnert claims to have shown that the ontogenetic retardation of the development of an organ is connected with a phyletic diminution of its functional importance. This he has undoubtedly done, and the special part of his work is full of interesting facts bearing upon minor anatomical problems. It is not, however, easy to follow him in his excursion into theoretical questions. Having asserted the nature of the parallelism between ontogeny and phylogeny, he proceeds to seek for a causal explanation, and finds it in the diminution and final loss of the

faculty of cell-regeneration, due to the diminution and loss of the stimulus of functional excitation. In the case of limbs, the functional excitation is supplied by the stress to which the limbs are subjected in supporting the body weight. The primitive limb consisted of many rays; eventually five only were directly used for support, the remaining rows degenerated, and are now represented only by the "sesamoids." In further development of races, groups arose in which a lesser number of digits than five were used for support: the digits which were no longer used lost the stimulus of functional excitation and became degenerate, and their degeneracy was represented in ontogeny by a retardation in histological differentiation. Dr. Mehnert is clearly a Neo-Lamarckian as well as a follower of Roux, and he speaks, as clearly as Lamarck himself might speak, of the importance of individual effort in increasing or diminishing functional excitation. But there is one thing that Dr. Mehnert does not succeed in accounting for, nor has any Neo-Lamarckian yet succeeded in accounting for it, the constitution of the germ, which is such that the pentadactyle hand is first formed, even when it is destined to be monodactyle or didactyle in the adult, and this in an embryo developing under conditions which preclude the action of functional excitation. His principle of diminished cell-regeneration following upon diminished functional excitation obliges him to reject the teachings of those authors who assert a primary blastogenic phylogenesis, but he is constrained to admit some sort of preformation in the germ cell, and falls back on the specific energy of affinity possessed by every atom according to its position in the periodic system of elements. The course of speculation which starts from such premises can hardly lead to useful conclusions. The following is an example of the author's generalisations.

"Ontogenetic evolutions are only the consequential manifestations of phyletic epigenesis, which again is in itself only a specialised evolution of the molecular energies and affinities which integrate the individual. That which in the earlier periods of the earth was epigenesis, or, as one may now say phyletic evolution, is now become ontogenetic evolution."

One can see what he wants to explain, but one cannot admit that he explains it. Towards the close of his work he states that—

"individual growth and development is a mosaic-work of cells and organs produced by mass correlation which, as a result of different phyletic functional efforts, charges the germ with different regenerative energies."

The same idea might be expressed much more simply. The problem is, how and by what mechanism are variations in adult structures able to affect the germ in such a manner that they may be reproduced in the next generation? Mehnert seeks to prove that they do affect the germ, but he has not succeeded in suggesting the manner in which they can do so. Weismann's contention that acquired characters are not inherited has yet to be shown to be untenable, and his position will hardly be shaken by an argument which invokes the individual efforts of ancestors with limbs of theoretical construction in order to explain the observed facts in the ontogenies of their presumed descendants.

RADIATION VISIBLE AND INVISIBLE.

Light Visible and Invisible. By Prof. Silvanus P. Thompson, D.Sc., F.R.S., &c., Principal of, and Professor of Physics in, the City and Guilds Technical College, Finsbury. Pp. xii + 294. (London: Macmillan and Co., Ltd., 1897.)

THIS is an age of rapid growth of scientific knowledge when the theory of to-day becomes the established fact of to-morrow, and in no province have our ideas shown a more rapid advance than on the subject of radiations in the ether. First of all, the electromagnetic theory of Maxwell upheld that light was an electrical phenomenon, and this received its confirmation by the experimental genius of Hertz, and the subject of optics thus became attached to the domain of electricity. Later came the discovery, by Röntgen, of a kind of radiation entirely different from anything before known, and this was soon after followed by a discovery of a type of invisible radiation emitted by uranium and its salts, which apparently possess properties intermediate between ultra-violet light and Röntgen rays, but the cause of whose production is at present one of the mysteries of science. Besides these, many other types of radiation, either apparent or real, have been noted, and the subject of transformation of radiations at the surface of bodies is now engaging the attention of many observers. The last few years has thus been an era of unexampled activity in the study of radiations, and there is considerable evidence that this activity will be productive of still further results in the near future.

In this little volume—"Light Visible and Invisible"—Prof. Silvanus Thompson has published in full the six lectures delivered at the Royal Institution at Christmas 1897. At the outset we feel that the title of these lectures is rather a misnomer, for even a most imaginative person would hardly have expected that the volume was to include, under the title "Light Visible and Invisible," a lecture on the subject of electromagnetic waves, as well as a discussion of the properties and production of Röntgen rays.

These lectures are of necessity popular, and, as the author has very well said in his preface,

"two things are expected of a lecturer who undertakes a course of Christmas lectures at the Royal Institution. In the first place, his discourses must be illustrated to the utmost extent by experiments. In the second, however simple the language in which scientific facts and principles are described, every discourse must sound, at least, some note of modernity, must reflect some wave of recent progress in science"

After reading the well-illustrated volume before us, no one will be disposed to deny the author has fulfilled the conditions laid down in the preface. The subject is very simply treated, and abounds with experimental illustrations; and though there is little, if anything, in the volume with which a scientific student would not be more or less acquainted, we cannot but admire the attractive way in which the information is laid before us. It came rather as a surprise to us, however, to find the "note of modernity" strongly sounded on the now well-worn subject of Röntgen rays.

The first lecture opens with a discussion of the

elementary theory of light and shadows, and closes with some interesting details of Japanese magic mirrors, which are, I believe, not generally known. We then pass on in later lectures to the consideration of the visible spectrum and the eye, and here we are given an account of some of the effects of persistence of impressions on the retina, with its modern applications in the zoetrope and animatograph. In a series of six lectures it is manifestly impossible to treat of the whole subject of light with any degree of fullness, so that no apology is needed for the absence of any account of interference, diffraction, spectrum analysis, and many other branches of the subject, which are by no means the least important. The author has, however, a chapter devoted to the polarisation of light, which he considers a subject inherently simple rendered difficult by the nomenclature applied to it. In his own words—

"Scientific men often fall into the habit of using long and difficult words to express very simple and easy ideas. The natural consequence is that people are often led to think that there is some difficulty about a really easy subject, whereas the main difficulty is to understand the meaning of the word selected to describe it. The word 'polarisation' used in optics is one of these terms. It sounds very learned and difficult, but the idea it is intended to convey is really very simple."

If this be true, the original inventor of the term must turn in his grave at the thought of the way he has unwittingly retarded the dissemination of scientific knowledge.

The elementary consideration of polarisation is admirably treated by the aid of simple mechanical analogies, and is made so ridiculously simple that no one could fail to grasp the fundamental ideas. The best and fullest part of the lectures, however, is that which deals with the ultra-violet portion of the spectrum, which is extremely well treated with a wealth of experimental illustration, and will be read with great interest by all students of physics. The discussion of the ultra-red portion of the spectrum leads up to the consideration of electromagnetic waves, of which a short account is given.

In the last chapter we reach the high-water mark of popular literature in an account of Röntgen rays, including, as it does, an interview of Prof. Röntgen by a newspaper reporter, and photographs of the hands of scientific celebrities, as well as of a cigar and spectacle case, with whose contents we are all now so familiar.

A short appendix is added to each of the lectures, treating with more completeness of one or more of the ideas which arose in the lecture. For example, we are given an account of anomalous dispersion brought up to date by the introduction of a brief account of Helmholtz's investigation of the change of refractive index with wave-length. A brief summary of the elastic solid and electromagnetic theories is appended, and also a *résumé* of recent work on invisible radiations.

The author, in his first lecture, used the conception of wave surfaces to explain the elementary theory of optics rather than the time-honoured geometrical method. Every one will agree with the author that the only true method of treatment is to disregard the source, and to consider only the march of the wave front; and the sooner it is incorporated in our elementary text-books on optics the better. In the appendix to the first lecture a method of determining the ordinary optical formulæ from the consideration of wave surfaces is shortly explained, and in the author's words, "these [formulæ] are, in fact, established much more readily on this basis than by the cumbrous methods that are consecrated by their adoption in every text-book of geometrical optics." This appendix is, however, rather out of place in a popular treatise of this kind, for it will be passed over by the ordinary reader, and it is not sufficiently complete to be of much service to the student of optics.

In the beginning of this article attention was drawn to the fact that the title of the volume hardly leads one to expect the nature of its contents. The author is apparently not quite sure whether he is justified in including an account of electromagnetic waves and Röntgen rays in a book on "Visible and Invisible Light"; at any rate, he considers it necessary to explain his nomenclature. On p. 272 (in a chapter entitled "Röntgen Light") we have the following:—

"You will have noticed that I have spoken of these rays as 'Röntgen Light.' But are we really justified in calling it light? It is invisible to our eyes; but then so also is ordinary ultra-violet light, and so is infra-red light and Hertzian light. And there are other kinds of light, too, amongst them one discovered during last year by M. Becquerel and myself, which are invisible. But if the Röntgen light can be neither reflected nor refracted, neither diffracted nor polarised, what reason have we for calling it light at all? In fact, direct proof that it consists of transverse waves is wanting. Many conjectures have been formed respecting its nature. Röntgen himself suggested that it might consist of longitudinal vibrations. Others have suggested ether streams, ether vortices, or even streams of minute corpuscles. At one time the notion that it might be simply an extreme kind of ultra-violet light of excessively minute wave-length was favoured by physicists, who were disposed to explain the absence of refraction and the high penetrative power of the rays upon von Helmholtz's theory of anomalous dispersion, according to which the ultra-violet spectrum at the extreme end ought to double back on itself. The most probable suggestion yet made, and the only one that seems to account for the strange lateral emission of the rays right up to the plane of the antikathode, is that of Sir George Stokes."

We cannot at all agree with the author in speaking of Röntgen light, as it is a very misleading term, and presupposes a knowledge which we do not at present possess. The objection to the signification lies in the fact that the underlying view of what we call light is that which gives us a sense of vision. It is quite true that we call the ultra-red and ultra-violet portions of the spectrum invisible light, but that is purely a matter of convenience, as in the spectrum these waves are merely a continuation of the visible spectrum, and are not bounded by any hard and fast line; but it is quite another matter to apply the term to Röntgen rays, and when there is a perfectly general term "radiation" ready to our hand, it is far preferable to use it. It is far more accurate, as well as more scientific, to speak of Röntgen and uranium radiation rather than Röntgen and uranium light. It is time that the term light was restricted to its original signification, and it should not be carelessly extended to forms of radiation the nature and properties of which are probably very different to ordinary light vibrations.

E. R.

PHYSICO-CHEMICAL RESEARCH.

Arbeiten des physikalisch-chemischen Instituts der Universität Leipzig aus den Jahren 1887 *bis* 1896. Collected and edited by Prof. W. Ostwald, Director of the Institute. Four vols. Pp. x + 556; iv + 496; iv + 656; iv + 550. (Leipzig: Engelmann, 1897.)

THE year 1887 may be regarded as a red-letter year in the history of physical chemistry, for it was then that the birth of the theory of electrolytic dissociation took place.

Although the osmotic theory of solutions is somewhat older, it was also in 1887 that van 't Hoff published his classical memoir on the *rôle* of osmotic pressure in the analogy between solutions and gases.

These two theories, taken in conjunction with the law of mass action, form the starting-point of a new era in physical chemistry, and have thrown an entirely new light on miscellaneous facts taken from all domains of chemistry and physics.

The correlation of apparently isolated phenomena, which was then for the first time rendered possible, has materially advanced the study of philosophical chemistry.

Concurrently with the publication of these theories, Prof. Ostwald was transferred from Riga to the University of Leipzig, where he, assisted by numerous students of all nationalities, at once began the further investigation and application of the new and powerful weapons which had just been added to the armoury of the chemist.

An idea of what Prof. Ostwald has accomplished may be gathered from a perusal of the volumes now before us, representing only a selected portion of the work which has emanated from his laboratory during the past nine or ten years.

In all, the four volumes contain reprints of 104 papers published in the *Zeitschrift für physikalische Chemie*, which, by the way, was also founded in 1887. In many respects the papers are remarkable; not only are many of them classics, but they embrace nearly every department of chemistry. We are tolerably well acquainted with the specialisation which takes place in most of the continental laboratories, and we are often wearied with a harvest of papers all dealing with minute details and with different aspects of one and the same subject. This of course is necessary and important, but it is none the less tedious.

The volumes which are now brought under our notice form, on the other hand, a refreshing change; the majority of the papers are of fundamental importance, and are an eloquent tribute to the power and versatility of the leading spirit.

The occasion for their issue was the opening, at the beginning of the present year, of the new Physico-chemical Institute at Leipzig. In collecting the pamphlets for re-issue, the chronological order of publication has wisely been departed from, in order, by arranging the articles under their appropriate headings, to produce a more or less homogeneous budget, and thus to facilitate a general survey of the gradual development of each branch.

The contents of the first volume are classified into sections headed: general, the electrical conductivity of dissolved substances, and the electrolytic dissociation of acids and bases.

The advantages of this arrangement are obvious. By bringing together closely allied investigations, a great deal of time is saved and misconceptions are often prevented. The second paper in the volume, for instance, contains the diagrammatical description of Ostwald's famous experiment which is intended to remove the last doubts as to the validity of the assumption of free electrically charged ions. This experiment, it may be remembered, consists in bringing a negatively charged body up to an insulated vessel filled with a solution of potassium chloride, and connected by means of a siphon with a similar vessel at a little distance. If the siphon be now removed and then the charged body, there will be an excess of positively charged potassium ions in the adjacent vessel and negatively charged chlorine ions in the other. By conducting away the electricity the potassium, for example, assumes the ordinary form, and acting on the water present develops hydrogen, which can be collected in suitable apparatus and tested. This experiment has, in these columns and elsewhere, given rise to a great deal of unnecessary controversy which would probably never have been printed if the critics had been aware of the existence of the next important paper in the volume, namely, that on free ions, where the imaginary experiment was actually put to the test and found to give results in harmony both qualitatively and quantitatively with what had been predicted.

The second volume contains chapters on homogeneous and heterogeneous equilibrium, velocity of reactions and the determination of molecular weights; including a great many of the original papers by Beckmann and others on the theory and practice of the ebullioscopic and cryoscopic methods now universally employed.

Volume iii. deals entirely with electro-chemistry, and contains some of the most important recent contributions to our knowledge of this interesting branch. Contact electricity, the theory of the galvanic cell, with applications, and polarisation are treated of. Nowhere, perhaps, have the modern theories led to such brilliant results as in the department of electro-chemistry. It may be somewhat invidious to mention any investigation in particular; but, now that we are accustomed to look on the galvanic battery merely as an engine driven by osmotic pressure, we cannot allow this opportunity to pass without alluding to Nernst's classical memoir on the osmotic origin of the current.

The last volume of the series, besides several miscellaneous articles, contains an account of investigations on viscosity, diffusion, and optical and thermal phenomena.

The various pamphlets are reprinted word for word; and although the 'prentice hand is occasionally discernible, yet in many cases where corrections or additions have been rendered necessary these follow on immediately after the original article. Unfortunately some of the typographical errors present in the original have been reproduced, whilst others have here and there crept in. The equations at the top of p. 271, vol. iii., for example, are affected by both sources of error.

In conclusion, we have only to remark that if short notes giving a summary of contemporaneous work and ideas from other laboratories had been interspersed

between the different sections and individual papers, the unity of the whole would have been such as to make the four volumes of the *Arbeiten* an excellent special treatise on physical chemistry.

Although this would undoubtedly have increased the value of the work to outsiders, it is perhaps rather antagonistic to its *raison d'être*, since it is primarily the collected published papers from the physico-chemical laboratory of the University of Leipzig. As such it is not only a welcome souvenir to those who have worked in the old laboratory, but it should be in the hands of all who are interested in physical chemistry. JOHN SHIELDS.

OUR BOOK SHELF.

Archives of the Roentgen Ray. Vol. ii. No. 2. *Radiography in Marine Zoology*, being a Supplement to the *Archives of the Roentgen Ray.* The British Echinodermata. By R. Norris Wolfenden, M.D. Cantab. (London: The Rebman Publishing Company, 1897.)

To deal with the above-named publications in inverse order, it may be remarked that Dr. Wolfenden's treatise of fifteen quarto plates and six pages of letterpress is the outcome of the radiography, by means of a 10-inch spark-coil, of a collection of Echinodermata dredged in the Orkney Seas during 1896-97. The author claims that it has been his endeavour "to show that the new method of radiography may be made of considerable service in zoology, as an accessory to dissection and description." The plates are mostly inartistic and of no practical value to the zoologist—at best but poor examples of the radiographer's art. While they betoken a laudable desire on their originator's part to develop the new light of physical science, they partake of the nature of mere experimental memoranda such as are usually made a basis for fuller investigation and allowed to pass unpublished.

Of the *Archives* it may be noted that with the number under review the title is changed from that "of Skiagraphy" to that "of the Roentgen Ray." The seventeen pages before us are chiefly conspicuous as containing a full report of the inaugural meeting of the Röntgen Society of London, a combination of a conversazione, a trade exhibit, and a concert, set around a presidential address. The latter, reported *in extenso*, deals with the history, development, and application of the Röntgen discovery, to the invoking of Shakespeare. Special stress is laid upon the advantages likely to accrue to the medical profession by the employment of the X-ray tube; and since the members of that profession seem likely to profit both by its use and its user, they ought for the future to be among its foremost advocates. It is thus but appropriate that the body of the *Archives* should be devoted to a brief description of five plates mainly illustrative of the osteological phenomena of "acromegaly"—which we would remark is now more correctly known as megalacria. Beyond this there are a few desultory notes of a practical order, but we are unable to detect anything which might not have been communicated in the customary form to one or other of the established scientific societies. We fail to see the justification for the foundation of a new society, and shudder at the assertion that there are already "three journals established for the publication of observations and discoveries connected with the Roentgen rays," not to say at the suggestion of rivalry in the wording of the cover of the issue under review. Concerning the zoological departure, however, a good purpose will have been served, in the awakening of the mind of the physicist to the fact that animals exist and have a form and symmetry capable of scientific treatment.

Practical Electricity and Magnetism. By John Henderson, B.Sc. (Edin.), A.I.E.E. Pp. xv + 388. (London: Longmans, Green, and Co., 1898.)

THIS little volume, the second of a series of laboratory manuals at present being brought out by Mr. Henderson in conjunction with Mr. Joyce, has certainly many points about it which are not only original, but which should also render it of the greatest value in the physical laboratory.

It is designed "to provide a course of instruction for carrying out a progressive series of experiments in electricity and magnetism," and, though it is written, not for technical students, but for students of science, one is nevertheless struck with the author's extremely high ideal of laboratory experimental work. The student receives at the outset a preliminary admonition which cannot be described as other than most excellent and to the point. He is assumed to have plenty of time at his disposal, and not to be engaged in getting through a certain set of experiments in a given time: conditions which can hardly be expected of students preparing themselves for any practical examination, or even in every case of students engaged in original research. The writer's effort to inculcate an almost impossible ideal is none the less a most praiseworthy feature of the book.

The descriptions of recent experimental work are well up to date, though perhaps such work has received here and there an almost undue prominence. At the end of each section, a list of references to original papers bearing on the subject is given. These lists, which are carefully prepared, will recommend the book to all who are engaged in looking up in detail any particular branch of the subject.

The notation used is not always happily chosen, as, for example, the double meaning of the letter R on p. 108-9; and the book is by no means entirely devoid of unfortunate mistakes, as in the table on p. 378, where the mechanical equivalent of heat is given as "42400 grms. per °C" instead of "42400 grm.-cms. per °C." Such faults will, however, no doubt disappear in a second edition.

Much practical and detailed advice on the carrying out of experiments is given, which it would be hard to find in so concise a form elsewhere; and, though the manual is for this very reason not exactly readable, yet this portion of the work, together with the tables of references to original papers already alluded to, and the concluding set of numerical tables and physical constants, combine to make up a most useful work for the physical laboratory.

D. K. M.

La photographie et l'étude des nuages. Par Jacques Boyer. 8vo. Pp. vi + 80. Twenty-one illustrations. (Paris: C. Mendel, 1898.)

AT the International Meteorological Conference at Munich, in 1891, a Committee was formed to consider the question of concerted observations on the direction of motion and the height of clouds, and subsequently various countries were invited to undertake special observations during a year commencing May 1, 1896, a period which was afterwards extended until August 1897. A Committee was also appointed to prepare a Cloud Atlas, based on the classification of Dr. Hildebrandsson and the late Mr. R. Abercromby, and instructions for observing and measuring the altitudes of the clouds by theodolites and photogrammeters were prepared by experts in this branch of meteorological science. The present handy little volume is the outcome of this action, and brings into a small compass a considerable amount of useful information which is spread over various publications, some of which are not easily accessible. It is divided into four parts: (1) the history of the subject from the middle of the eighteenth century; (2) classification according to the atlas above referred to, with a number of

illustrations; (3) description of the photographic apparatus employed, and (4) the method of measuring the pictures obtained. The two last chapters will be very valuable for any one proposing to undertake the difficult task of photographing the clouds, and of determining their heights and movements. In referring to the various attempts at cloud classification, we do not find any mention of "Cloudland," by the late Rev. W. C. Ley.

Proceedings of the London Mathematical Society. Vol. xxviii. Demy 8vo, pp. 594. (London: Francis Hodgson, 1897.)

THIS collection of thirty-four original papers on every branch of mathematics affords abundant evidence that English mathematicians are not behindhand in moving with the times. If proof be needed that the younger generation of mathematicians are quite following in the lines of those that have gone before them, it may be sufficient to mention that at least six of the papers are by men who have graduated at Cambridge since the year 1886. As might be expected, "Partitions" and "Groups" occupy a prominent place, seven of the papers being devoted to them. The former of these two subjects is ably introduced by Major MacMahon, F.R.S., in his address on "Combinatory Analysis," delivered on retiring from the office of president; and the publication of the outlines of seven lectures on the "Partitions of Numbers," delivered by the late Prof. Sylvester at King's College, London, in 1859, is another important feature. On the other hand, "hyper-Euclidian geometry" is conspicuous by its absence, and applied mathematics is represented by eight papers only.

During the past year the London Mathematical Society has lost two members in addition to the late Prof. Sylvester: the Rev. Alexander Freeman, who died on June 12, 1897, and Lieut.-Colonel John Robert Campbell, who died on June 23. Colonel Campbell, besides serving on the Council, was a benefactor to the Society, and we understand that had it not been for his munificence it would have been impossible for the Society to issue such large and interesting volumes of *Proceedings* as the one now before us.

First Year of Scientific Knowledge. By Paul Bert. Translated by Madame Paul Bert. Revised and partly re-written by Richard Wormell, D.Sc., M.A.; and Montagu Lubbock, M.D. Pp. vi + 417. (London: Relfe Brothers, Ltd. Paris: Armand Colin and Co.)

THIS is a revised edition of a work which has had a very successful career, but is constructed upon a plan which has little to commend it. The revision has consisted in bringing the information into line with current scientific knowledge, the plan of the book remaining as in the original. The rudiments of zoology, botany, geology, physics, chemistry, animal physiology, and vegetable physiology are all described in the four hundred pages which constitute the text, so that the book is comprehensive in its scope, if nothing else. The chief fault we have to find is that far too many technical terms are defined and used, so that the unfortunate pupils who are introduced to natural history by this book will be given the idea that science consists chiefly of words of Greek origin, and an unpronounceable terminology.

Who's Who, 1898. Edited by Douglas Sladen. Pp. xviii + 846. (London: A. and C. Black, 1898.)

THIS is undoubtedly the handiest biographical dictionary and compendium of information, referring to prominent persons and their doings, in existence. It contains nearly seven thousand biographies—mostly autobiographies—of the leading men and women of the day, and a large amount of information in addition. Among the general contents of interest to men of science is a list of Royal, National and learned societies, showing the addresses of the societies, secretaries' names, annual subscriptions and other conditions of membership. We notice also a table of university degrees, with the correct explanation of each, a list of chairs and professors in the great universities of the United Kingdom, arranged alphabetically by their chairs, and a list of Fellows of the Royal Society (most of whom appear among the biographies). The volume is one to be kept on the writing table for ready reference; and it possesses the merit of including in its pages biographical details of more men of science than usually figure in similar reference books, though even now some of the minor literary lights could be struck out with advantage to make room for well-known scientific men who have been omitted.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Mechanism of Self-fertilisation in the Banana.

I PROPOSE to describe here the mechanism of fertilisation in the banana plant.

(1) *Packing of the inflorescence.*—The inflorescence in this plant is packed air-tight in the large red-coloured bracts, whose margins are secured in place by a sort of cement. If we remove one of these bracts and examine the buds within, we find that the reproductive organs are also packed air-tight in the perianth. A closer examination of this packing is necessary to understand its efficiency.

The perianth consists of an outer whorl and an inner whorl; the outer one consists of three sepals, usually united into an elongated concave hood. (Sometimes, instead of the three being united together, only two are united and one is free, which in the bud is partially overlapped by the other. Very rarely the three are quite free. In about fifty examples I examined, I

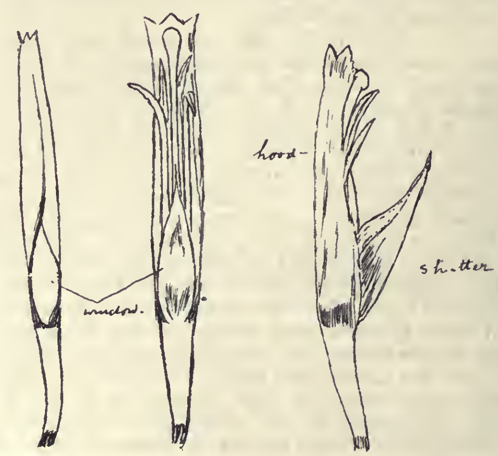

Fig. I Fig. 2 Fig. 3

got only one flower with all the three sepals distinct.) The margins of the hood are folded inwards, so that they overlap each other. There is no fixed rule as to which is the outer, and which the inner, sepal. Sometimes the right overlaps the left, or *vice versâ*. This overlapping is not complete throughout their length, and cannot possibly be so. For, to ensure the packing being air-tight, the pectinate inflorescence must necessarily be concavo-convex, *i.e.* convex without and concave within; and obviously any cylindrical tube bent concavo-convexly must necessarily leave a gap or a window at the bottom (see Figs. 1 and 2).

This window would be a very weak point in the packing, and hence most accessible to insects or other injurious agencies if the outer packing became loose by accident. This weak

point must, therefore, be guarded first; and we see that nature has done it by closing the window with one of the petals of the inner whorl. This petal is convex in front and concave behind, while the hood is convex behind and concave in front. This arrangement shuts off the window completely (Fig. 3). The petaloid shutter is secured in its place, on either side, by the margins of the hood to nearly an eighth of an inch. These margins are very much thinned out, and are also cemented together. The shutter, being on the concave side of the bud, comes in contact with the convex bract beneath, which thus helps to keep it in position. The top of the hood is closed similarly air-tight by its margins. The inner whorl—*i.e.* the corolla—is represented usually by the shutter alone. Sometimes, however, two petals are present, and very rarely all the three.

The male organs, thus tightly packed, can neither move from their place, nor can they be assailed by any foreign element from without.

(2) *Arrangement of the stamens.*—On removing the hood and the shutter we come to the andrœcium, which consists of four or five stamens. The filaments are petaloid and erect, thus embracing the pistil completely. The anthers are adnate or dorsifixed. They are also introrse, *i.e.* turned towards the stigma.

Let us now proceed to the pistil, and examine it in the different stages of its growth. In the early state—*i.e.* before it is ripe, and before the anthers are ripe also—the style and

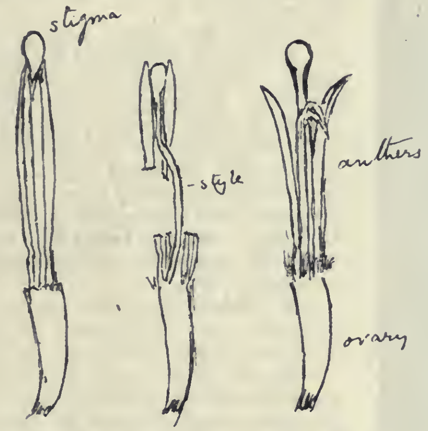

Fig. 4 Fig. 5 Fig. 6

the stigma project beyond the andrœcium. If this state continued, self-fertilisation would be impossible. The stamens must either overtake the stigma, or the stigma must be at the mercy of insects or the wind for pollination. The stamens are not quick enough in growth to overtake the stigma; so what happens is this. By the time the anthers are ripe, the style shortens in length by bending nearly at right angles in two places (often marked by horizontal grooves in early stages), and thus brings the stigma in contact with the pollen (see Figs. 4 and 5). After pollination is completed, the style straightens again and projects, as before, beyond the andrœcium (see Fig. 6). Stages intermediate between Figs. 4 and 5, may be seen if we examine the flowers from without inwards. With the straightening of the style, the anthers become free and curve outwards. The bracts fall off; the shutter drops away; the hood withers, and the style dries gradually.

Kolhapur, India, February 17. GOPAL R. TAMBE.

Stereoscopic Projection of Lantern Slides.

IN your report of the meeting of the Physical Society on February 26 (NATURE, p. 454), I notice an account of the exhibition, by Prof. T. C. Porter, of a somewhat complicated apparatus for exhibiting lantern slides in stereoscopic relief. An equally elaborate arrangement, depending on the use of polarised light, was exhibited at the British Association at Nottingham in 1893. It may possibly, therefore, be of interest to call attention to the much simpler means of accomplishing the same result, which suggested itself to me some time ago, but I subsequently found that it had been invented previously by Lieut.-Colonel Moëssard under the name of *monocular* stereoscope (*Cosmos*, May 23, 1896).

In this stereoscope one eye views one of the pictures directly, while the other eye sees the other picture after reflection at two mirrors, the angle between whose planes can be adjusted so as to bring the image into apparent coincidence with the picture seen by the first eye. In viewing distant pictures, such as lantern slides, a projecting partition, with a flange whose breadth is nearly equal to the distance between the two eyes, is all that is necessary to prevent either eye from seeing the wrong picture.

For lantern work, either two pictures could be projected side by side with separate lanterns, or two small views could be photographed side by side on the same slide, and thus enable stereoscopic effects to be shown with a single ordinary lantern.

Moreover, by turning the arrangement of mirrors through 90° it can be made to displace the image seen by one eye *vertically* instead of horizontally. This would enable the two pictures of an oblong view to be projected *one above the other*, instead of side by side, and viewed with the same apparatus as before, but differently arranged. As regards the foreshortening of the upper picture, this would be to a great extent compensated for by the fact that the lantern itself projected the picture upwards.

It is evident that two pairs of mirrors, one for each eye, could be used if desirable. G. H. BRYAN.

The Aurora of March 15.

I WAS fortunate enough to witness the display of the aurora on the night of the 15th, and think that some of the appearances may be of interest to those who did not see them, but who have recorded the accompanying magnetic disturbances.

The display began in the north-east about eight o'clock, by the appearance of a brilliant band of light, rising from behind a cloud 45° from the horizon, and extending about 30° in a south-westerly direction. This band might have been mistaken for a search-light, the edges were so sharp. The colour was the characteristic greenish hue of the aurora.

After persisting steadily for five minutes the band gradually broadened and shortened, and became a bright patch, which continued until the end. The display spread over the northern sky to the west, where another patch appeared. At nine o'clock the display was very fine, with two patches east and west, and right overhead seemed to be the apex of a parabola with beams of light streaming northwards. Looking southwards, occasional flashes of a yellowish pink colour could be seen. About ten o'clock the whole energy of the display seemed to become concentrated in the east and west patches, and great flashes of light connecting the two. After this the brightness seemed to gradually diminish.

So bright was the aurora at its height that the grey granite walls of the houses were illumined by the flashes.

Aberdeen, March 25. A. GEO. SMITH

On Phosphorescent Sap in Superior Plants.

IN answer to the question of Prof. Giglioli in NATURE of March 3 (p. 412), I beg to observe that in Meyen's "System der Pflanzen-Physiologie," which was certainly in its time a standard work, there is to be found in vol. ii. p. 203 (Berlin, 1838) a short but concise statement of the phosphorescence of the milk-juice in *Euphorbia phosphorea*, on the authority of v. Martius ("Reise in Brasilien," ii. pp. 726 and 746), as also a reference to a communication by Mornay (*Philosophical Transactions*, vol. vi. p. 279), on the phosphorescence of the milk-juice" in einem rankenden Gewächse, Cipo de Cunanam genannt, welches zwischen Monte Santo und dem Flusse Bendego wuchs und wahrscheinlich eine Asclepiadee oder ein Apocynee ist." M. W. BEIJERINCK.

Delft, Holland.

A Remarkable Case of Correlation.

A VERY interesting case of correlation is recorded in the *Bulletin* of the Botanical Department, Jamaica, for December 1897.

Particular attention has been paid lately to the selection of good Ripley pine-apples, and it is found that if there is a broad red stripe in the centre of the leaf the fruit will turn out good; in other cases the fruit goes into holes at the bottom, and is attacked by ants. S. N. C.

MRS. BISHOP'S KOREA.[1]

WHEN, after returning from the perils and hardships of her adventures in the Bakhtiari country of Persia, Mrs. Bishop announced her intention of making an extensive journey in Eastern Asia, her friends knew that she would not return without having something of interest to tell regarding her travels in little-known regions. Although unfortunately ignorant of the languages of the countries in which she was to travel, and therefore dependent on others to a large extent, Mrs. Bishop had most carefully prepared herself for making all necessary observations and records. She is particularly to be congratulated on her skill as a photographer. The points of view were very carefully chosen, and the exposures accurately calculated, while the practice of developing the plates at the time, allowed duplicates to be taken if the first negative proved defective. The result is one of the best collections of photographs which we have seen as the result of a travelling amateur. We must congratulate the publishers also on the manner of reproduction employed: the more important views are printed as separate plates by the half-tone process, the others are reproduced as line-and-stipple blocks in the text, allowing the book to be printed on unglazed paper, and giving the volumes a lightness which is as desirable as it is rare.

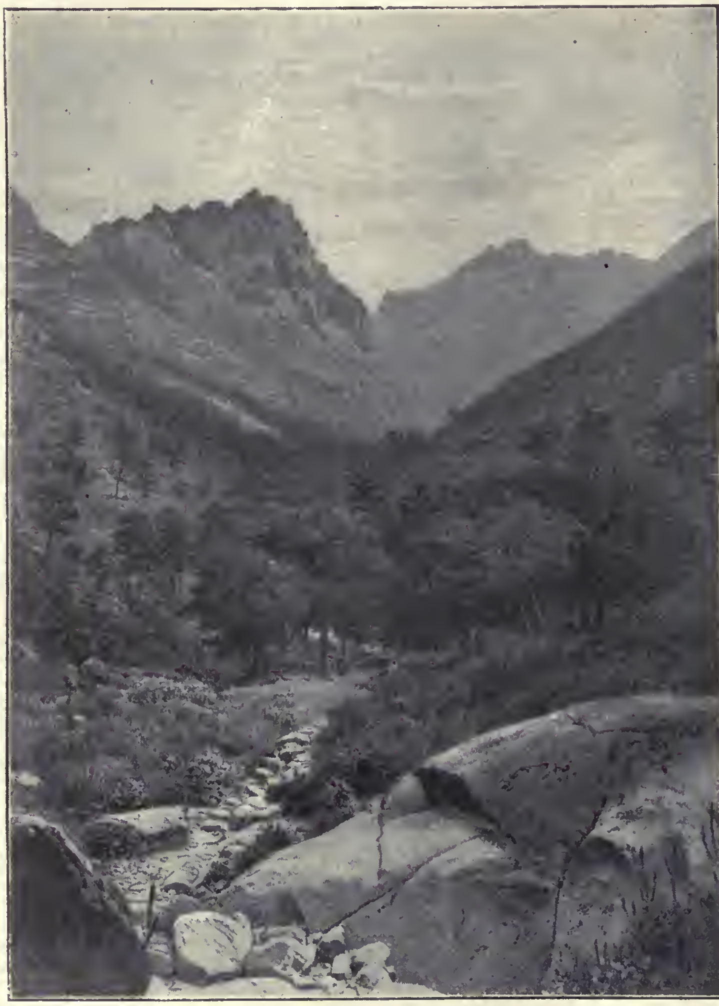

FIG. 1.—A Canyon in the Diamond Mountains.

Mrs. Bishop deals here with only a portion of her recent travels. Her important tour through Sze-chuan, on which she read a paper to the Royal Geographical Society—the first paper ever read by a lady to that Society—is not referred to, and the journey through Manchuria is but lightly touched on. Korea is the central theme; and although the interests of the authoress were obviously with the social and political aspects of the country rather than with its physical and biological conditions, she succeeds in giving an excellent general account, all the more valuable because not a little rubbish has been written by chance visitors at the treaty-ports. We may be pardoned if we feel a little regretful that—for example—the character of the interesting rock in the foreground of the photograph we reproduce (Fig. 1) is not described; but doubtless, the pioneer work having been accomplished, scientific travellers will follow, who can tell us whether the stone is merely water-worn or bears the sign-manual of ice.

We have one definite fault to find, and that is with the spelling of Russian place-names. Wladivostok is an incorrect transliteration. A German would write Wladiwostok properly enough; but the Russian letter *B* can only be represented by *v* in English, and the usual form of the name *Vladivostok* is the only correct one. There are some other slips—such as Richofen for Richthofen, and the terms flora and denudation are applied in a popular rather than a scientific sense.

Mrs. Bishop describes her landing at Chemulpo, and the journey to Seoul by land; one could hardly say by road, for "traffic has worn for itself a track, often indefinite, but usually straggling over and sterilising a width enough for three or four highways, and often making a new departure to avoid deep mud-holes." A residence in the insanitary and unsavoury Seoul followed, and then a journey by sampan up the south branch of the Han River, which was previously almost unknown to Europeans; then up the north branch of the river, and on ponies to the Diamond Mountains, and northward to Wönsun on the east coast. Returning to Chemulpo by sea, Mrs. Bishop was strongly advised by the British Consul to leave the country, and so crossed to China and made her way *viâ* Newchwang into Manchuria. It was a journey full of interest and of danger from floods, and the undisciplined Chinese armies on their way to the Korean war. Then she went *viâ* Nagasaki to Vladivostok, studied the Korean colonies in Siberia, and tried to enter Korea from the north; but the rivers were impassable, and another long sea-voyage was necessary. A second residence in Seoul led to a journey northward along the old road to China for 200 miles. A third and final visit to Seoul occupied the last few months of 1896. As Mrs. Bishop lived in the village inns when travelling, and was in constant communication with the diplomatic agents and missionaries while in the capital, her opportunities for seeing native life and learning the state of affairs in the country were exceptionally good.

Her special study was the people. In a note we learn

[1] "Korea and her Neighbours. A narrative of travel, with an account of the recent vicissitudes and present position of the country." By Mrs. Bishop (Isabella L. Bird), F.R.G.S. With a preface by Sir Walter C. Hillier, K.C.M.G., late H.B.M.'s Consul-General for Korea. With maps and illustrations. 2 vols. (London: John Murray, 1898.)

that the average size of 1060 men, measured at Seoul in January 1897, by Mr. A. B. Stripling, was height 5 ft. 11¼ in., chest-measurement 31 in., and circumference of head 21½ in. The maximum figures were respectively 5 ft. 11¼ in., 39¼ in., and 23¼ in. The physique is generally good, and the people possess many amiable qualities. The total population is estimated at from 12,000,000 to 13,000,000. Most of the people are very poor, and have no inducements to thrift; any wealth they may gather is at the mercy of the official class, who are mainly, if not entirely, responsible for the miserable condition of the country. Under the just rule of the Russians in Eastern Siberia, Mrs. Bishop found the Korean emigrants happy and enterprising, making good profits from their farms and inhabiting comfortable houses. Given good government, people and resources being as they are would ensure prosperity to Korea. Into the tangled political history of the unhappy country we cannot enter here, nor can we refer to the many curious customs, ceremonials and beliefs, which are set forth at considerable length. These, perhaps, constitute the most valuable part of the book, for Mrs. Bishop caught Korea in an interesting transition period, when the old subjugation to China was being repudiated for ever, and reforms of many kinds were being introduced. The Altar of the Spirits of the Land, at which the ceremony of repudiation was carried out, is shown in Fig. 2. Few contrasts are more striking than that presented by Seoul at her first and at her last visit; when the filthy chaos of huts surrounding the palace gave place to well-ordered streets of good houses. The problem of the fourfold influence of Russian, Chinese, Japanese and European interests is very well handled. Of the industries of Korea the most interesting is the cultivation of gin-seng, the description of the processes employed in the manufacture of the dried root being, we believe, the fullest yet published.

The future of Korea is still uncertain, but it is bound to play a prominent part in the politics of the Far East; and this book will hold a place as a valuable work of reference for many years to come. HUGH ROBERT MILL.

FIG. 2.—Altar of the Spirits of the Land.

ASTRONOMICAL RESULTS FROM THE CAPE OBSERVATORY.[1]

THESE three volumes, issued under the superintendence of Dr. Gill, form in some respects a very remarkable production. Not so much on account of the very numerous observations, whose discussion furnishes forth these weighty books, as by reason of the widespread assistance rendered by many astronomers, whose energies Dr. Gill has quickened, whose results he has collected, stamped with his own individuality, and incorporated in the "Annals of the Cape Observatory." There are very few instances in which the director of an observatory has been willing to take up a laborious piece of work at the suggestion of an astronomer, however eminent, go through the wearisome task of making the observations, and then be willing to hand over his results to an independent authority for final discussion or criticism. It is this quality of self-abnegation, which strikes us as so complete and worthy of imitation. We congratulate Dr. Gill on his tactful skill, by which he has emerged from his self-imposed task, without friction with his collaborators, and been able to present to the world, in a complete form, the result of a scheme which he carefully planned and carried to a successful issue. We think it an especial merit in Dr. Gill's work, that he has perceived the value of strengthening his heliometer observations by combining with them the results made with similar instruments elsewhere. It was quite within his power and instrumental means to have derived the solar parallax from observations of the asteroids made solely at the Cape Observatory. Other observers could have done the same work, but separate discussions, made at irregular intervals and under varying conditions, do not possess the proportionate authority that attaches to one discussion made with several instruments on a combined plan. Moreover, one feels that the last word has been said, for some years at least, on this subject of solar parallax, by means of heliometer observations. Every observer must feel that, singly, he cannot do more than has already been done collectively. There can be no temptation to repeat the work. Consequently the owners of this class of instruments are freed from this particular investigation, for which the heliometer seems especially well fitted, and are at liberty to pursue other inquiries with advantage. It might be worth while just to mention, that to get the full power of a heliometer a considerable number of meridian observations is necessary. In this case some thousands came under the discriminating examination of Prof. Auwers. To use this mass of observations on one series of measures would be extravagant, but when combined with all the heliometer observations in a final inquiry, this cost of time and labour is disregarded, since they contribute to the increased accuracy of so large a body of measures. It is a true economy which Dr. Gill has practised, and the success which has followed it will bear much fruit in the future.

In the inquiry from which the solar parallax is deduced, we notice that no less than six observatories have contributed heliometer measures. Besides that of the Cape, we have New Haven (Yale College), Leipzig, Göttingen, Bamberg, and the Oxford Radcliffe Observatory, all furnishing measures of some or all of the three planets, Iris, Victoria, and Sappho, from stars in a previously selected zone, through which the planets passed. Several have further assisted by making a careful triangulation of the selected stars. The position

[1] "Annals of the Cape Observatory." Vol. iii. The Cape Photographic Durchmusterung. Vol. vi. Solar Parallax from Heliometer Observations of Minor Planets. Vol. vii. Solar Parallax from Observations of Victoria and Sappho. (London: Published by order of the Lords Commissioners of the Admiralty, 1896.)

of these stars has been determined at "all the principal observatories," to use Dr. Gill's phrase, who apparently grew tired of enumerating all the institutions to which he is indebted for the completeness of this section of the work. The final value of the coordinates has been made the subject of a discussion by Prof. Auwers, which may well form a model for similar inquiries, and will be carefully studied by the professional astronomer engaged in similar work. Into minute details which arise in this section, as well as in the use and reduction of the heliometer measures themselves, it is impossible to enter here with sufficient fullness to make the involved process at all clear. The whole interest centres in the nicety with which small residuals are treated. For a similar reason it would be impertinent to offer any criticism which would imply that we have given to the volume the same anxious study and consideration which the combined authors have devoted to their subject. Dr. Gill has supported himself by the ablest authorities in meridional astronomy, his own experience with the heliometer to which he has devoted years of study in perfecting the mechanical arrangements and details is profound, and we have no doubt that we have here all that can be effected by sagacity and experience in deriving the best results from observations which are as perfect as we yet know how to make them. The final outcome of the observations which, in their main intention, were devoted to deriving the value of the solar parallax may be thus presented.

Heliometer observations of	Iris, discussed by	Dr. Elkin...	$8''.8120 \pm 0''.0090$
	Victoria ,,	Dr. Gill ...	8.8013 ± 0.0061
	Sappho ,,	Dr. Gill ...	8.7981 ± 0.0114
Meridian observations of	Iris ,,	Dr. Auwers	8.771 ± 0.130
	Victoria ,,	Dr. Auwers	8.845 ± 0.051
	Sappho ,,	Dr. Auwers	8.626 ± 0.118

The mean value from the heliometer measures is $8''.8036 \pm 0''.0046$, while the meridian observations give $8''.806 \pm 0''.030$, but for reasons stated, Dr. Gill is inclined to adopt as a final value $8''.802 \pm 0.005$. Though this result of itself would be a satisfactory outcome, the accuracy of the observations permits some other astronomical constants to be derived, either directly or through their relations with other known constants. The Victoria observations give with some confidence the mass of the moon $= \dfrac{1}{81.702 \pm 0.094}$. For other constants, such as the nutation, it is necessary to assume the luni solar precession. The value adopted is $50''.367 \pm 0''.004$, but the source from which it is obtained is not very clearly stated, neither is the epoch to which it refers. Apparently it is taken from Newcomb's discussion in the *Astronomical Journal*, No. 359; but in that paper we have not been able to find this particular value, nor the probable error with which it is accompanied. With this value of the precession, however, and the exact amount is immaterial for this purpose, the constant of nutation is $9''.2068$, and pursuing the same line of inquiry the constant, $\dfrac{C-A}{C}$ (employing the ordinary notation), is 0.0032825. Adopting Clark's value for the equatorial radius of the earth, the aberration constant is found to be $20''.467 \pm 0''.012$. Here as elsewhere the most probable value of the solar parallax is assumed $8''.802$.

The remaining volume, which contains the southern "Durchmusterung," between the limits $-18°$ to $-37°$ declination, is in its way quite as remarkable as the two volumes which we have been considering. Herein we have the first-fruits of the application of photography to the determination of star positions on a large scale. The old and the new methods are brought sharply into contrast. One would naturally like to institute a comparison between the time necessary for the production of these zones, and that required for similar work, either at Bonn or Cordova. But such a comparison is not easy, nor probably would it be fair. The plates that were taken at the Cape were measured at Groningen. Much time must have been lost in correspondence and in settling the details of a new method. Experience had to be acquired in the most suitable methods of measuring with new and untried apparatus. Prof. Kapteyn was necessarily occupied by his University duties, and could only devote his leisure to the preparation of the catalogue—a leisure which he gave unstintingly; and Dr. Gill is to be congratulated on the good fortune that supplied him with so able and willing a coadjutor.

The plates were taken with a rapid rectilinear Dallmeyer lens of six inches aperture and fifty-four inches focus. During the course of the work this lens was re-polished, and a portion of the work duplicated with a second lens; but allowing for all interruptions, the work that was begun on April 15, 1885, was finished in December 1890, with the result that the whole sky was photographed from the South Pole to $-19°$ declination. The free area of each plate was five degrees square, more than 600 being required to cover this portion of the heavens once, without any duplication. At first, when plates were rather slow in action, an hour's exposure was given; but this time was subsequently reduced to about thirty minutes. It is instructive to notice that many plates on a first examination had to be rejected, owing to the fainter stars not having impressed themselves on the film, on account of mist, dewing of the objective, or bad definition. "The more thorough examination necessarily made by Prof. Kapteyn in course of measurement, brought to light a good many more plates which it seemed desirable to re-photograph, so that some of the areas have been photographed three, four, and even five times." Such a report will not be very satisfactory reading for those engaged on the "Carte du Ciel."

The measurement was effected in a manner that necessitated very small corrections to the original readings, in order to obtain the approximate star places, referred to the equinox of 1875; indeed, Prof. Kapteyn says that the coordinates read from the instrument might have been entered directly in the catalogue. We can form a tolerably accurate notion of the time occupied in measuring the plates, for it is stated that on good rich plates two assistants could measure 300 to 400 stars in an hour. Probably 200 would represent the average, and since this portion of the catalogue contains 152,598 stars, we have about 750 hours of actual measurement for one complete examination. Such a rapid collection of results needs no comment. The average distribution of the stars throughout the whole area is possibly of greater consequence than the actual number measured. Of course, the number to a square degree varies very much in different parts of the sky. In the sparsest parts, that is, in Galactic Latitude about $-70°$, this number falls to 6.28, rather less than in Argelander; but a comparison of *mean* results with other zones gives the following numbers.

Cape Photographic Survey ...	25.43	stars to square degree.
Bonn N. Durchmusterung ...	15.19	,, ,,
Schönfeld	18.21	,, ,,
Thome	56.1	,, ,,

The arrangement of the stars in the catalogue, and the degree of accuracy aimed at, is the same as in the familiar Bonn work, namely one-tenth of a second of time in R.A., and a tenth of a minute of declination. A comparison between the places here given with those of other catalogues shows that the probable error of a photographic determination contrasts most favourably with that derived from other processes. This is clearly shown by the following table.

Authority.		Prob. error in α.	Prob. error in δ.
	° °	s.	″
Argelander ..	− 2 to + 38 ...	± 0·70 ...	± 25·4
Schönfeld	− 2 to − 23 ...	0·38 ...	9·6
Cordova	− 22 to − 32 ...	0·42 ...	13·8
Cape Photog. ...	− 19 to − 38 ...	0·27 ...	2·6
Lalande (1880)...	+ 1 to + 5 ...	0·224 ..	2·4

We do not propose in this place to follow Prof. Kapteyn in his discussion of the magnitudes assigned in the work, and his comparison with the visual magnitudes recorded by other observers. The section is very interesting and likely to lead to much discussion, owing to the curious fact disclosed, that while this catalogue is poorer in number of stars in the poor regions of the sky, it is at the same time richer in the rich regions, than is the catalogue of Schönfeld, from which fact Prof. Kapteyn concludes that the stars in the Milky Way are generally more chemically active than the stars in the other regions of the sky. W. E. P.

NOTES.

REFERRING to our inquiry (p. 488) as to disturbances of terrestrial magnetism during January and February, Dr. C. Chree writes from the Kew Observatory as follows:—"With the exception of some small movements on the 10th, our magnetic curves were very quiet from January 1 to 14; but thereafter there was a disturbed time, lasting over January 15 to 21. The disturbance was greatest from the 15th to the 18th—when it was well marked—less on the 19th and 20th, and still less on the 21st. The 22nd and 23rd were very quiet days. The rest of January was quiet generally, with a few small movements. February was quiet up to the 10th, with the exception of some slight movements on the 5th. From February 11 to 16 there was a moderately disturbed time; on the 20th and 21st there were some smaller movements. It was then quiet to the end of the month. 'Quiet' is, of course, only a relative word; there is seldom a day in which some slight movement, beyond the mere diurnal inequality, is not visible. In the case of the disturbances on January 15–21 and February 11–16, it was rather a case of numerous well-defined oscillations than of sudden comparatively isolated movements of a conspicuous character."

A CONFERENCE of the International Aeronautical Commission opens to-day at Strassburg, and will continue for several days. Among the experiments to be performed during the meeting is the graduation of thermographs down to −200° C. by means of a jet of liquid air procured by the Linde method. Dr. Hergesell, the president of the conference, will present a report upon the thermometric experiments already referred to in NATURE (p. 470). M. Besançon will send up a balloon of twelve hundred cubic feet capacity, equipped with meteorograms, which it is estimated will attain an altitude of about twenty thousand feet. Several members of the Paris Academy of Sciences have signified their intention to attend the conference.

THE Paris correspondent of the *Times* reports that at Monday's sitting of the Academy of Sciences the question of the French national time was introduced by M. Bouquet de la Grye, the president of the Paris Geographical Society and a member of the Section of Navigation and Geography. The fact was recalled that on February 24 the Chamber of Deputies passed without discussion and on a show of hands a Bill providing that French national time should be advanced by 9 minutes 11 seconds, which was tantamount to the adoption of the meridian of Greenwich by France. The Bureau des Longitudes has, however, sent a protest to the Minister of Education, and the protest has been forwarded to the President of the Senate. M. Bouquet de la Grye asked the Academy to refer the whole question to the joint Sections of Astronomy and Navigation to be reported upon. This motion was supported by M. Janssen and adopted after some explanations from M. Berthelot and M. Bertrand, the two permanent secretaries.

IT is announced that the Russian Government has decided to adopt the metric system.

A FRENCH ironclad launched a few days ago was christened the *Lavoisier*.

PROF. J. E. KEELER has been elected director of the Lick Observatory, in succession to Prof. E. S. Holden.

THE current number of the *Proceedings of the Royal Society* contains an obituary notice of Pasteur by Prof. Percy Frankland, F.R.S.

MR. A. D. BERRINGTON is on the point of retiring from the post of chief inspector of fisheries and assistant secretary to the Board of Trade. Among the fishery inspectors who preceded Mr. Berrington were Mr. Frank Buckland and Prof. Huxley.

THE Public Buildings Expenses Bill, providing 2,250,000*l*. for new public buildings in London, passed through Committee of the House of Commons on Tuesday. Included in the expenditure authorised by the Bill is a grant of 800,000*l*. for buildings in connection with the Science and Art Museum at South Kensington.

A SWEDISH scientific expedition to Klondike, conducted by Dr. Nordenskiöld, arranged to leave Stockholm on March 23. Dr. Nordenskiöld will be accompanied by Dr. Gunnar Andersson, professor at the Stockholm High School, and four other persons. The expedition is expected to be absent about two years. Immediately after its return the expedition will make known the results, not only in Sweden, but also to scientific societies in other countries.

IT is reported that Herr J. Stadling, who accompanied Herr Andrée's expedition to Spitsbergen in 1896, has been appointed by the Swedish Anthropological and Geographical Society to undertake a search through Siberia in order to make inquiries as to the fate of Herr Andrée's balloon expedition. For this purpose Herr Stadling has received the Vega stipendium from the Society. He will start with a companion from Stockholm early in April, and the journey will last probably until January next.

A COMMITTEE has been appointed by the Home Secretary to inquire into the extent to which water gas and other gases containing a large proportion of carbon monoxide are being manufactured and used for heating, lighting and other purposes, and the dangers which may attend such manufacture and use. The committee is composed of Lord Belper (chairman), Mr. H. H. Cunynghame, Dr. Parsons, Dr. Haldane, and Prof. Ramsay; with Mr. J. Pedder, of the Home Office, as secretary.

AT the meeting of the Manchester Literary and Philosophical Society on Tuesday, the President presented the Wilde medal for 1898 to Sir Joseph Dalton Hooker, G.C.S.I., F.R.S.; the Dalton medal to Dr. Edward Schunck, F.R.S.; and the Wilde premium for 1898 to Mr. John Butterworth. The Wilde lecture, "On the Physical Basis of Psychical Events," was afterwards delivered by Prof. Michael Foster.

THE British Association Committee of the Ethnographical Survey is desirous to obtain the services of qualified observers in numerous parts of the United Kingdom, for the purpose of inquiring into all or any of the following subjects: (1) physical types of the inhabitants; (2) current traditions and beliefs; (3) peculiarities of dialect; (4) monuments and other remains of ancient culture; (5) historical evidence as to continuity of race.

Communications should be addressed to Mr. E. Sidney Hartland, hon. sec. Ethnographical Survey Committee, British Association, Burlington House, W.

PROF. N. E. HANSEN, professor of horticulture at Brookings, South Dakota, who was sent to Eastern Europe and Asia to secure new seeds and plants for the Agricultural Department of the United States, is (says *Science*) now preparing his report for publication, after an extended trip through Eastern Russia, Trans-Caucasia, Russian Turkestan, Western China, and Siberia. Many promising varieties were obtained, and about three car-loads of seed will be distributed to State experiment stations. These seeds, it is expected, will be chiefly of value in the arid regions, the purpose of Prof. Hansen's trip being to obtain such as were distinguished for resistance to drought and heat.

THE following are among the lecture arrangements at the Royal Institution after Easter :—The Right Hon. Lord Rayleigh, F.R.S., three lectures on natural philosophy ; Dr. E. E. Klein, two lectures on modern methods and their achievements in bacteriology ; Mr. J. A. Thomson, two lectures on the biology of Spring. The Friday evening meetings of the members will be resumed on April 22, when Mr. W. H. M. Christie, C.B., the Astronomer Royal, will deliver a discourse on the recent eclipse ; succeeding discourses will probably be given by Prof. A. Gray, Mr. E. A. Minchin, Prof. W. A. Tilden, the Right Hon. D. H. Madden, Lieut.-General the Hon. Sir A. Clarke, Prof. W. M. Flinders Petrie, the Right Hon. Lord Rayleigh, and other gentlemen.

Science announces that Prof. W. A. Rogers died at Waterville, Maine, on March 1, aged sixty-one years. He was assistant professor of astronomy in the observatory of Harvard University from 1875 until 1886, when he accepted a call to the professorship of physics and astronomy at Colby University. He had expected to enter on a professorship at Alfred University, N.Y., on April 1. Prof. Rogers was a member of the United States National Academy, and a past vice-president of the American Association for the Advancement of Science. He made important contributions to astronomy and physics, especially to the technique of measurement.

STORMS of more than ordinary severity were experienced on our coasts last week, and were accompanied by a good deal of snow in many districts. A cyclonic disturbance, which arrived from the Atlantic on March 23, crossed the northern portion of Scotland, travelling in a south-easterly direction ; and, after continuing its course down the east coast of England, the central area of the disturbance crossed the North Sea, and eventually passed over Germany. Owing to the prevalence of anticyclonic conditions over Scandinavia, the track followed by the storm was somewhat unusual, and its progress was very slow, while the area of high barometric pressure advancing in the rear of the disturbance gained additional energy. It was particularly to this last feature that the storm owed its chief violence ; the gales experienced from the 23rd to the 27th belonged to the rear segment of the storm-area, and were wholly from the north and north-east. They have proved very disastrous on our coasts, and have also wrought considerable damage over the inland parts of the country. The general characteristics of the disturbance, both in its cause and effect, closely resembled those of the storm which occurred at the end of last November.

THE report of the Council of the Scottish Geographical Society was presented at a general meeting held on March 23. After referring to the general reports of the meteorological stations, the Council state that, as intimated in the last report, the observations at the intermediate station on Ben Nevis, at a height of 2322 feet, were resumed last summer. The observations form a very complete series, thanks to the great enthusiasm and self-denial of the observers, Mr. T. S. Muir and Mr. A. Drysdale, aided by several valuable self-recording instruments. From the varying cyclonic and anticyclonic types of weather which prevailed during the ten weeks of observation—July 19 to end of September 1897—the Society is now in possession of simultaneous hourly observations from the three observatories on Ben Nevis, which are really the indispensable data in investigating the problems relating to the vertical gradients of the temperature, pressure, and humidity of the atmosphere and its movements. The work of making daily maps showing the rainfall at 120 stations well distributed over Scotland is in progress ; and to these are being added the figures showing the hours of the occurrence of fog at the Scottish lighthouses. The large series of maps, in illustration of the mean monthly and annual atmospheric pressure and temperature of the British Islands, is well in hand. The maps of isothermals are finished, and the maps of isobars will be on the stone in a few days, and no time will be lost in issuing the number to members. The Council announced a Diamond Jubilee donation of 100*l.* from one of the members, of which 50*l.* is for discussion of separate parts of the work of the Ben Nevis observatories, and 50*l.* in furtherance of the Society's work. It was also announced that the late Hon. Ralph Abercromby bequeathed a legacy of 100*l.* to the Society.

Das Wetter of February reproduces a lecture, recently delivered by Dr. G. Hellmann, on the interesting question of mild winters. The facts are based upon the temperature observations at Berlin, for which place observations are available since the early part of the previous century, and the subject is divided into three parts : (1) the frequency and succession of mild winters, (2) their general character, and (3) what kind of summer weather may be expected after a mild winter. For the purpose of this investigation, the author defines a mild winter as one in which the mean temperature of December and January is above the average, and in which the sum of the deviations in both months amounts at least to 2° C. A table giving the monthly deviations for November to August shows that since 1720 there have been forty-eight mild winters in Berlin, that they are never isolated, but occur in groups of two or three years, and especially after a long period of colder winters. The intervals between two groups of mild winters vary from nine to fourteen years. With regard to the character of mild winters, the table shows clearly that they are usually of long duration. The chances are 79 to 21 that after a mild winter, February will also have a high mean temperature. Another characteristic of mild winters is that the greatest deviations of temperature usually occur in January. Whether a mild winter will be damp or dry depends chiefly upon the distribution of atmospheric pressure ; the present winter is of the mild and dry type. The general distribution of pressure between December 5, 1897, and January 29 last, is illustrated by weekly charts. With respect to the influence of mild winters upon the subsequent weather, and especially of the summer, if July and August be taken together as representing the summer, it is found that the chances are 44 per cent. that a warm summer will follow a moderately mild winter ; while after a very mild winter, the chances of a warm summer amount to 68 per cent. The cases of mild *dry* winters, such as the present, are rare ; if the deficient rainfall is not compensated during spring time the summer is likely to be wet, and consequently cool.

THE *British Medical Journal* for March 19 contains an important paper by Dr. Luigi Sambon, on the "Etiology of Sunstroke." Dr. Sambon adopts what at first appears a somewhat startling theory, namely, that sunstroke is not due to excessive heat or exposure to the sun, but is

an infectious disease due to a specific organism. The author's case rests on three lines of argument. He begins by showing that excessive heat does not produce the disease; stokers, oven-cleaners, miners, and iron-workers are exposed to temperatures higher than those of any known climate, without ever contracting the malady. The Assam tea-planters and the closely-shaven Chinese are constantly exposed to the hottest sun, and are equally exempt. Dr. Sambon next discusses the geographical distribution of the disease, and proves that the areas in which it is endemic are strictly defined. It is very common in the low-lying regions of the Eastern United States, between the Appalachians and the Atlantic; it is unknown in Europe; it extends along the Nile Valley, Red Sea, and Persian Gulf; it prevails in the Indo-Gangetic alluvial plain, but not on the adjacent Indian highlands. Another peculiar feature of the disease explicable on the infection theory is the occurrence of epidemics, which may decimate hospital wards and not affect men exposed to greater heat and sun. Dr. Sambon concludes that the distribution, etiology, morbid anatomy, and epidemic character of the disease together demonstrate its organic origin. The specific organism has not been detected, but the author believes it lives in the superficial layers of the soil, and is conveyed to the lungs or alimentary canal by dust.

A PRELIMINARY statement just issued by the Canadian Geological Survey, in advance of the detailed annual report, shows that the gold produced by the Dominion in 1897 amounted to a value of 1,238,000*l*. This means that the Canadian gold output increased by 122·6 per cent. in a single year. In 1896 gold only formed 12·30 per cent. of the total mineral produce of the country (reckoning by value), while coal and building material provided 31·94 per cent. and 15·72 per cent. respectively. In 1897 gold rose to the second place on the list, with a percentage of 21·50, coal and building material being credited with percentages of 25·31 and 12·50 respectively.

A SHIP model experiment tank is being built at Washington by the United States Navy, at a cost of about 100,000 dollars. From a description in the *New York Engineer*, we learn that the tank will be a concrete lined basin, surmounted by a brick building 500 feet long by 50 feet wide, the basin itself being 47 feet long by 43 feet wide by 14 feet deep. On each side of the basin, for its whole length, will be iron rails supporting the ends of a carriage spanning the basin, this carriage being propelled along the tank with the model and measuring dynamometer attached, the model being guided along while still floating freely in the water. The carriage, with all dependent on it, is driven along the tank by four electric motors, taking current from a wire by means of trolley poles. The degree of resistance encountered by the model in passing through the water, also the time taken and the distance traversed, are all recorded diagrammatically and by electrical means. Hydraulic brake cylinders on each side of the carriage provide for stopping the carriage when run at very high speeds. The models experimented with will be one-twentieth of the actual size of the vessels, the model for a 400-foot ship being thus 20 feet long. Tests will be made with models for merchant vessels as well as war-ships, and special experiments will be conducted as to the effects of propellers of different sizes and shapes, and the effects of the shape of the after-end of vessels upon the efficiency of the propeller.

MR. J. C. GOUDIE contributes the following interesting observations to the February number of the *Victorian Naturalist*, the journal and magazine of the Field Naturalists' Club of Victoria:—"A small species of ant, commonly distributed in the Mallee, has a curious habit of keeping in close confinement a rather large mealy aphis, which feeds on the stems of young eucalypts. Round and over these aphides the ants construct a domed covering of particles of bark, grass, &c., which serves the double purpose of imprisoning the aphides and excluding other ants. Some of these coverings appear to be entirely closed, while others have an opening left in the edge; this doorway is, however, constantly guarded by a pair of ants, which continually move about in the open space, and seem much impressed with the importance of the duty assigned to them. Each enclosure contains generally from three to a dozen aphides, and about the same number of ants. Upon making a breach in some of these structures, for the purpose of observation, I have noticed that many of the 'live stock' were immediately seized by the ants and forcibly removed to a place of safety. The ant under notice is about a quarter of an inch in length, and is of a uniform dark reddish-brown colour, and forms its ordinary habitation under logs, or in old rotten stumps, and sometimes in the ground. Several other species of ants are very assiduous in their attendance on the various aphides, Tetigonidæ, and coccids, but the above is the only kind I have noticed that uses such extraordinary means to secure a monopoly of the much-prized 'honey-dew.'"

THE *Journal* of the Society of Arts for March 4 contains the account of a lecture, by Captain Baden-Powell, on "Kites," in which the advantages and disadvantages of different forms and combinations of kites, as well as their various uses for lifting, traction, reconnoitring, and other practical purposes are fully discussed.

KOENIGS and Lie have proved that if the poles are taken of an arbitrary plane with respect to the conics of a Steiner's surface, their locus is another Steiner's surface. A new proof of this theorem is given by Prof. A. Brambilla, in the *Rendiconto* of the Naples Academy, who makes use of symbolic notation enabling him to introduce considerable symmetry into the equations.

SOME doubt has existed as to who was the first to discover the microscopic Foraminifera, and to apply the microscope to the investigation of rock-structure. From a communication by Prof. Giovanni Capellini to the *Rendiconto* of the Bologna Academy, it would appear that on March 3, 1711, a paper, entitled *De variis arenis*, was communicated to that Academy by Jacopo Bartolomeo Beccari, of Bologna, thus indicating that priority must be awarded to Beccari.

ACCORDING to the views communicated to the Bologna Academy by Prof. Federico Delpino, it would appear that the lesser celandine (*Ranunculus Ficaria*) of our English hedgerows is to be regarded as the dwarf form of a dimorphic plant, whose dimorphism is of the kind known as *gynodiœcism*. Prof. Delpino contends that the hermaphrodite form is the larger plant, so common on the Riviera, known as *Ficaria calthæfolia*, and that our *Ficaria ranunculoides*, Moench, is the smaller female form of the same species. This theory accounts for the facility with which the celandine is propagated agamically, and the sterility of its pollen.

A REPORT on the colour of water by M. Ad. Kemna, of the Antwerp Waterworks Company, has been recently reprinted from the *Bulletin de la Société belge de Géologie*, and is published by Polleunis and Ceuterick, of Brussels. In it the views of various writers, from Arago downwards, on the physical, chemical, and organic causes of the different colours of different waters, are summarised, M. Spring's theories being dealt with at considerable length. M. Kemna indicates the practical bearing of these investigations on the testing of water supplies of towns, and describes different methods of applying tests. Of these, the tests known as the Hazen tests, and due to Mr. Allen Hazen, of Massachusetts, find most favour with the author.

ATTENTION has several times been called in NATURE to the various optical illusions by which one of two equal straight lines can be made to look larger than the other by drawing them in particular positions, or a series of parallel lines can be made to look askew by drawing slanting lines across them. A very full and detailed account of these illusions is now given, by Herr Wilhelm Wundt, in a paper reprinted from the *Abhandlungen der k. Sächs. Gesellschaft der Wissenschaften*, and published by B. G. Teubner in Leipzig. The paper is illustrated by sixty-five woodcuts, showing all the principal and many less-known appearances of this class, and Herr Wundt discusses at considerable length the causes of these subjective phenomena, whose existence appears to have been first made known by J. Oppel in 1854.

SUNSHINE recorders and their indications are often regarded with suspicion by meteorologists; and not without cause, for it can hardly be claimed that any sunshine recorder in use is a satisfactory physical instrument. In the current number of the *Quarterly Journal* of the Royal Meteorological Society, Mr. R. H. Curtis reports the results of a comparison between the sunshine records obtained simultaneously from a Campbell-Stokes burning recorder, and from a Jordan photographic recorder. The comparison indicates that the Campbell-Stokes instrument gives records which can be measured with a fair degree of accuracy by different persons, and are not liable to as much uncertainty as the records of the Jordan instrument. Contrary to the belief of many observers the photographic records were not, upon the whole, in excess of the records obtained with the Campbell-Stokes instrument.

IN the *Free Museum of Science and Art* (Philadelphia) for December, Dr. Brinton draws attention to a discovery among the ancient marbles of the Louvre of an admirable representation of the wearing of the murmex. It is figure No. 68 in the Salle des Caryatides. The discovery, says Dr. Brinton, removes all doubt of the correctness of his identification of the so-called bow-puller with the murmex. The bow-puller is the name generally given to a bronze object found in museums. The "collections and publications" section of this very useful bulletin is exceedingly good, and we are tempted to hope that our own museums may some day call forth the interest that is evidently felt by Americans in theirs.

THE *Reliquary and Illustrated Archæologist* for January last is almost entirely anthropological in interest. Mr. Leader Scott's account of the Gallic necropolis in Italy, discovered by Conte Giampieri Carletti on a tract of land at the foot of an indentation of Mount Montefortino, near Arcevia, is particularly interesting; while the next three articles—on some old-fashioned contrivances in Lakeland, by Mr. Swainson Cowper, on the modern use of bone skates, by Mr. Henry Balfour, and on beer and labour tallies, by Mr. Edward Lovett—lead us to the domestic antiquities of our own country, which are all too frequently neglected. The dairy appliances described, *inter alia*, by Mr. Cowper are very interesting, and we hope he will go on to give us sufficient material to work out the evolution of farm implements.

THE *American Anthropologist* for November and December last contains a specially good article on the aborigines of Formosa and the Liu-kiu islands, by Mr. Albrecht Wirth. The aborigines who cling to the savage state are short of stature, the majority being under 5 feet 6 inches. They have broad faces with low brows, straight and high noses wide at the nostrils, and lips not so thick even as those of the Malays. The subject of trephining in Mexico is dealt with by Carl Lumholtz and A. Hrdlicka, who give some valuable additional notes upon this interesting subject. Mr. Lewis W. Gunckel analyses the deities of Mayan inscriptions, an obscure subject not perhaps of sufficient interest to attract much general attention.

THE Geologists' Association have arranged an Easter excursion to Bridport and Weymouth, under the direction of Prof. J. F. Blake, Mr. W. H. Hudleston, F.R.S., and Mr. S. S. Buckman. The party will leave Paddington Station on Thursday, April 7, and will return on Tuesday, April 12.

PROF. H. G. SEELEY, F.R.S., will begin the summer course of lecture-excursions with the London Geological Field Class on Saturday, April 23. The subject of the series will be "The Physical Geography and Geology of the Thames and its Tributaries." This is the thirteenth annual course. Mr. R. H. Bentley, 43 Gloucester Road, South Hornsey, N., is the hon. secretary to this class, which provides a systematic course of geological teaching in the open country.

THE Society for the Protection of Birds has issued Part ii. of the Educational Series of leaflets, edited by Mr. H. E. Dresser. Thirteen leaflets are bound up in this part, and each contains interesting notes on the appearance, characteristics and habits of British birds. The information will induce the reader to observe bird-life with a sympathetic eye, and will thus further the Society's objects.

THE second number of the *Science Abstracts*, issued under the direction of the Institution of Electrical Engineers and the Physical Society, has just been issued. Additions have been made to the list of journals from which papers are abstracted, and it is proposed to considerably enlarge the monthly parts as time goes on. The staff of abstractors is also being increased. The value of *Science Abstracts* to the physicist and the electrical engineer is very great, and no student of physical science who wishes to keep in touch with the world of investigation can afford to neglect so serviceable a publication.

WE have received *Natural History Transactions*, vol. xiii. part 2, published by the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne, an institution which has recently completed its jubilee. The Society promotes an important museum, and detailed enumeration is given of the mammals, birds, and miscellaneous objects to the collections. Prof. G. S. Brady, F.R.S., has a long paper on the British species of Entomostraca belonging to Daphnia and other allied genera. A paper on the "Life History of Coal" seems to take up a great deal of valuable space, and suggests curtailment. There is much interesting information conveyed in the reports of the committees. Lord Armstrong has apparently been a munificent supporter of the Society. We are of opinion, though of course it may not fall in with local necessities, that much of the matter contained in this and similar publications might perhaps be condensed and printed in appendix form, so as to bring the papers and record of actual scientific progress more into prominence.—The *Proceedings* of the Bristol Naturalists' Society, vol. viii. part 2, has also reached us. There are several useful contributions in this nicely-printed publication, covering many branches of science. An interesting paper appears on the "Chemistry of Colliery Explosions," by Mr. Donald Stuart, which is supplemented by a plan of Timsbury Collieries, in Somersetshire, exhibiting the workings traversed by an explosion. Noticeable also is a paper, by Mr. S. S. Buckman and Mr. E. Wilson, on the "Geological Structure of the Upper Portion of Dundry Hill."

THE additions to the Zoological Society's Gardens during the past week include a Herring Gull (*Larus argentatus*), British, presented by Mrs. Hovell; three Bactrian Camels (*Camelus bactrianus*, ♀ ♀ ♀) from Central Asia, two Yaks (*Poephagus grunniens*, ♀ and juv.) from Tibet, a Beisa Antelope (*Oryx beisa*, ♂) from North-east Africa, a Burchell's Zebra (*Equus burchelli*, ♀) from South Africa, a Weka Rail (*Ocydromus australis*) from New Zealand, four Radiated Tortoises (*Testudo radiata*) from Madagascar, a Galapagan Tortoise (*Testudo galapagensis*) from the Galapagos Islands, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN APRIL 1898:—

April 3. Pallas 15′ south of *o* Eridani (mag. 4·1).
5–15. Mercury well visible in the evenings near Venus.
9. Juno (mag. 8·7) in opposition to the sun.
10. 13h. Mercury at greatest elongation (19° 23′ E.).
10. 14h. 38m. to 15h. 8m. A Ophiuchi (mag. 4·7) occulted by the moon.
10. Saturn. Outer minor axis of outer ring = 18″·14.
14. 5h. 51m. to 8h. 26m. Transit of Jupiter's Sat. III.
15. Venus. Illuminated portion of disc = 0·968.
15. Mars „ „ „ = 0·953.
16. 9h. 4m. Minimum of β Persei (Algol).
18. Mercury and Venus in conjunction (Mercury 3° 20′ N.).
19–20. Meteoric shower from near α Lyra (radiant 270° + 32°).
21. 9h. 11m. to 11h. 49m. Transit of Jupiter's Sat. III.
21. 15h. Mercury in conjunction with moon (Mercury 2° 2′ S.).
27. 6h. 41m. to 7h. 44m. 79 Geminorum (mag. 6·5) occulted by moon.
28. 12h. 34m. to 15h. 15m. Transit of Jupiter's Sat. III.
29. 13h. 1m. to 13h. 15h. ξ Leonis (mag. 5·2) occulted by moon.

FAVOURABLE APPARITION OF MERCURY.—The most convenient period in 1898 for observing Mercury will be during the fortnight from April 5 to 18, when the planet will become visible about an hour after sunset above the W. by N. horizon. He will reach his greatest eastern elongation on the morning of April 11, and will set on several evenings at about this time, a little more than two hours after the sun. Fortunately, at this special period, the planet will be situated within a few degrees of Venus, and the latter will form a brilliant guide to the position of Mercury. On April 5 Mercury will be apparently 6 degrees above Venus, and on ensuing nights the interval decreases until on April 18 the two objects will be in conjunction, Mercury being about 3° 20′ N. of Venus. Mercury will then appear on the north-west side of Venus, but is likely to be much fainter than before elongation, as he rapidly loses brightness owing to the crescent-phase which his disc assumes. The following are the times of setting of the sun, Mercury and Venus, and the intervals at which Mercury sets after the sun:—

Date 1898.	Sun sets.	Mercury sets.	Venus sets.	Mercury sets after sun.
	h. m.	h. m.	h. m.	h. m.
April 5	6 38	8 28	7 45	1 50
6	6 40	8 33	7 48	1 53
7	6 41	8 37	7 51	1 56
8	6 43	8 42	7 54	1 59
9	6 44	8 46	7 58	2 2
10	6 45	8 48	8 1	2 3
11	6 46	8 49	8 4	2 3
12	6 48	8 51	8 7	2 3
13	6 50	8 52	8 10	2 2
14	6 51	8 53	8 14	2 2
15	6 53	8 53	8 17	2 0
16	6 55	8 52	8 20	1 57
17	6 57	8 51	8 24	1 54
18	6 59	8 48	8 27	1 49

The conjunction of Mercury and Venus on April 18, at about 5h., does not appear to be mentioned in the *Nautical Almanac*.

COMET PERRINE.—Dr. F. Ristenpart has calculated the elements and ephemeris of this comet from the observations made on March 19, 21 and 22. These, as given in Circular No. 3 from Kiel, are as follows:—

Elements.

T = 1898 March 18·501. Berlin Mean Time.

$$\left.\begin{aligned} \omega &= 48^\circ\ 47'\cdot 1 \\ \Omega &= 263\ 16\cdot 4 \\ i &= 72\ 44\cdot 7 \end{aligned}\right\} 1898\cdot 0$$

$$\log q = 0\cdot 04316$$

Ephemeris for 12h. Berlin Mean Time.

1898.	α h. m. s.	δ ° ′	log Δ	Br.
March 31 ...	22 3 0	+28 24·8	0·2019	1·00
April 2 ...	11 30	30 22·0		
4 ...	20 14	32 16·4	0·2054	0·99
6 ...	29 12	34 7·8		
8 ...	22 38 24	+35 55·0	0·2110	0·89

We may mention that the elements calculated by Messrs. Hussey and Perrine are almost identical with those given above.

At the time of this comet's discovery its diameter was 2′, with a strong condensation, and a tail of length equal to 1°. It was then of the 7th magnitude.

TWO NEW VARIABLE STARS OF SHORT PERIOD.—Herren G. Müller and P. Kempf contribute some interesting data to the current number (No. 3483) of the *Astronomische Nachrichten*, relative to the two new variables of short period which were originally discovered during the series of zone observations for the second part of the Potsdam Photometric Durchmusterung. These two stars are BD + 20°·4200 and BD + 28°·3460, or, as they have been named, U Vulpeculæ and ST Cygni respectively.

The first of these stars, whose position for 1900 is R.A. 19h. 32m. 15s., declination + 20° 6′·6, has a period of nearly eight days, the light curve varying from mag. 6·9 or 7·0 at maximum to 7·6 at minimum; the epoch for the calculation of the maxima being 1897 October 2·47 Greenwich mean time. The light curve shows small secondary variations both in the ascending and descending portions, the rise to maximum and fall to minimum occupying equal intervals of time.

The second variable, whose position for 1900 is R.A. 19h. 40m. 49s., declination + 29° 1′·2, has a period of 3·844 days, the magnitudes at maximum and minimum being 6·6 and 7·4 respectively. The dates of maxima can be calculated from the epoch (maximum) 1897 October 4·66 Greenwich mean time + 3·844 E. In the case of this star the curves on either side maximum are not equal, but the rise to maximum comprises less time than the fall to minimum. The former occupies only 0·9 days, while the latter takes 2·9 days. The curve is described as similar to δ Cephei. The observations suggest that on the downward side of the curve, 1·75 days after the maximum, the light becomes stationary for a short period of time, afterwards decreasing to the next minimum.

VARIABLES AND THEIR COMPARISON STARS.—Variable star observers may be glad to know that Prof. E. C. Pickering is able to furnish the photometric magnitudes of a great many comparison stars for long-period variables, and that he will communicate the information in advance of publication should any one require it (*Harvard College Observatory Circular*, No. 27). Sequences of comparison stars have been selected for about one hundred variables, stars brighter than the tenth magnitude having been measured on at least three nights with the meridian photometer, and those from the eleventh to the thirteenth magnitude on two nights with the photometer having achromatic prisms. Observations are already completed for the following stars:—T Andromedæ, T Cassiopeiæ, R Andromedæ, S Ceti, S Cassiopeiæ, R Piscium, R Arietis, T Persei, *o* Ceti, S Persei, R Ceti, U Ceti, R Tauri, S Tauri, R Aurigæ, U Orionis, R Lyncis, R Geminorum, S Canis Minoris, R Cancri, S Hydræ, T Hydræ, R Ursæ Majoris, X Virginis, R Comæ, T Virginis, Y Virginis, T Ursæ Majoris, R Virginis, S Ursæ Majoris, U Virginis, R Hydræ, S Böotis, R Camelopardali, U Herculis, W Herculis, R Ursæ Minoris, R Draconis, χ Cygni, S Cygni, R Delphini, U Cygni, V Cygni, T Aquarii, T Cephei, S Cephei, SS Cygni, S Aquarii, R Pegasi, S Pegasi, R Aquarii, and R Cassiopeiæ.

Prof. Pickering adds that the brightness of each of these variables is being determined monthly by Argelander's method, and it would be a good thing if other observers would reduce their observations to the same scale of magnitudes, as then the desired uniformity in results would be obtained.

The variability of the star in Aquila, R.A. 19h. 33·3m., Decl. + 11° 29′ (1900), announced recently by the Rev. T. D. Anderson, has been corroborated by an examination of the Harvard photographs. Measures of fifty-seven negatives gave the maximum brightness 9·2, and minimum less than 12·9. The variations can be closely represented by the formula J.D. 2411550 + 330 E.

CONCAVE GRATINGS FOR STELLAR PHOTOGRAPHY.—Some experiments have been carried on quite recently at the Johns Hopkins University to investigate the value of the use of concave gratings for stellar spectroscopy, and the results obtained bid fair for further trials (*Astrophysical Journal*, vol. vii. No. 3, March). The methods originally suggested by Prof. Rowland have been developed; Dr. Poor has derived the formulæ, and directed the construction of the apparatus, while Mr. Alfred Mitchell has made the experiments and photographs. The method finally adopted was the direct one, the grating being the objective and spectroscope combined; the light from the star was thus reflected directly from the grating to the photographic plate. The best position for general work was found to be that in which the centre of the photographic plate falls on the axis of the grating. From the simplified general equation

$$r = \frac{\rho}{1 + \cos \nu}$$

in which ρ is the radius of curvature of the grating, R and v the spherical coordinates of the light source, and r and μ those of the curve on which the spectra are brought to a focus (R being ∞ and $\mu = 0$), it was found that those parts of the spectra where $\cos \mu$ could be assumed equal to unity, were brought to a focus on a circle whose radius is given by the above equation. The equation really represents a parabola, but within certain limits the spectrum may be considered normal. For a grating of medium dispersion, the entire spectrum will be practically normal; but with one giving larger dispersion, as a Rowland 21-foot, the scales of the middle and end differ by one and one-half parts in a thousand at a distance of 3° from the axis. It is necessary, therefore, that parabolic curved photographic plates must be used, but within certain limits they may be circular. In the experiments a small Rowland concave grating, of 15,000 lines to the inch, radius of curvature one metre, and ruled surface 1 × 2 inches, was employed, the photographic plates being bent to the proper radius. The spectra of Sirius, Capella, and Rigel obtained were 5 cm. long, and from 0·1 mm. to 1·5 mm. broad, and showed many lines.

Thus with an exposure of forty minutes, the spectrum of Sirius showed "16 hydrogen, H and K lines, and 15 other distinct fine lines." Capella, with forty minutes' exposure, gave F.G.h.H.K., and about fifty fine lines. It may be mentioned that these experiments were made on the fifth floor of the Physical Laboratory, "subject to the jar of street-cars and city traffic, as well as to dust and to the glare of electric lights," so that the results were not obtained under the *best* conditions.

A CATALOGUE OF 636 STARS.—No. 4 of the *Mittheilungen der Hamburger Sternwarte* contains a catalogue of stars observed by Herr W. Luther in the years 1885–92 with the meridian circle of the Hamburg Observatory. The observations in R.A. were made after the eye and ear method: those for declination by bringing the stars between two horizontal wires. The positions have all been reduced to the year 1885, and a comparison is made with the catalogue of the Astronomische Gessellschaft Zonen.

THE PREPARATION OF MARINE ANIMALS AND PLANTS AS TRANSPARENT LANTERN-SLIDES.

AT the request of the editor of NATURE, I give an abridged account of my essay in the volume of original researches published to commemorate the establishment of the Sheffield University College by Royal Charter in 1897. I shall confine myself mainly to the animals shown in the reproductions from four of the series of photographs taken by Mr. J. E. Atkinson, of our College, from some of my slides. Though on the whole these reproductions show the general facts fairly well, much of the minute detail is unavoidably lost, which is quite distinct when the mounted animals or photographs are somewhat magnified.

It is about eleven years ago that I first attempted to prepare lantern-slides with marine animals. At first I did not mount them in balsam, but very soon found that this is in almost every case not only desirable but even essential, since they so readily become mouldy, sometimes are attacked by mites, and are often far too opaque. Some also scale off from the glass and break to pieces, unless mounted. The success of the preparations depends almost as much on the proper mounting with balsam as on anything else, and sometimes the only way to get excellent results is to mount several, and pick out the best, which perhaps cannot be known until the specimens are finally mounted in balsam.

The methods necessary in mounting vary greatly in the case of different animals. Often little else is wanted than to arrange them properly on a lantern-glass, so that they touch it more or less completely all over their under surface, and then to drain and dry them. Many readily adhere round the drying edges, before the central parts are dry; and being thus fixed, they do not shrink laterally on further drying, but merely become thinner. On finally drying completely they may partially scale off, and it may be desirable to gum them down in one or more places, lest they should become loose when mounted in the balsam. There are a few animals that will not adhere at all to the glass, and yet shrink greatly. This circumstance has so far prevented me from making satisfactory slides of *Actiniæ*. I have succeeded with every other group.

Few animals are more easy to prepare than small flat fish like soles and dabs, 2 or 2½ inches long. These are killed by putting them into dilute alcohol, and arranged on the glass as soon as dead, whilst still limp. The chief matter is to arrange out the fins neatly. These soon dry, and adhere well; but in order that the side near the glass may keep flat, it is desirable on further drying to adopt a plan which I find most useful in many other cases. Very few, if any, animals will adhere in an objectionable manner to thin paper soaked with bees-wax, and, having laid such over the animal, pressure can be applied. What is wanted is that this pressure should be fairly uniform, and not merely on the thick parts. This is easily done by having a stout lantern-glass covered by two or three thicknesses

FIG. 1.—*Priapulus* in natural state.

of fine thin flannel, which is pressed down by a smaller or larger weight, so regulated as not to crush or distort the animal, but rather to retain as much as possible the natural shape and show the internal structure. The animal then dries through this flannel, and at the same time keeps sufficiently flat on the glass. Finally, any specially high parts can be pressed down by using a flat glass without flannel and a heavier weight.

A considerable variety of marine worms can be made into most excellent transparent slides, showing not only their general shape and colour, but also much of their internal structure. *Sabella* may be named as a specially good example. Such animals should be killed by keeping them for a short time in dilute alcohol. The aim should be to dry them before partial decomposition sets in and destroys the small blood-vessels. If all goes on well it is possible to dry and permanently preserve such worms as *Nereis*, so as to show not only the chief blood-vessels but even the smallest branches, and the blood may retain its red colour for years without any apparent change.

As an example of an animal mounted without staining, I give in Fig. 1 a reproduction from *Priapulus*. It should be killed by putting it into fresh water, and left in it so long that the body just begins to get limp. It can then be easily arranged on the glass, and adheres fairly well without lateral contraction. If mounted at once or previously kept in alcohol the body is too hard and will not adhere to the glass, and on drying contracts so much laterally as to become very unlike the living animal. The internal anatomy and general structure are best seen by cutting the animal open from end to end, and staining the whole with Beale's carmine or Kleinberg's hæmatoxylin. When thus

prepared, the muscular structure of the body-wall and the general internal anatomy are seen to great perfection.

I have not yet succeeded in preparing specimens of *Arenicola* when in their natural condition, so as to show their internal structure well, but have made some most excellent preparations by carefully cutting the animal open from end to end, spreading it out on the glass, and displacing the intestine and its appendages so as to be quite clear of the body, but yet to show the numerous blood-vessels passing to the lateral branchiæ from the main trunks along the intestine, which, however, are imperfectly seen in Fig. 2, which I give as an illustration of what may be done by partial dissection. Of their kind no preparations could be more satisfactory than some thus made, since the general anatomy is seen to great perfection, and the colour of the blood has remained unchanged for years, though in other cases, from some unexplained cause, it quickly turned brown.

It was the desire to preserve some of the beautiful Nudibranchs that led me to mount animals on slides. The lovely purple *Eolis* quickly loses its colour in alcohol. It should be killed in dilute alcohol, but kept in it a very short time, and then arranged on the glass and nearly dried. A strong solution of gum should then be placed over it, and the whole kept damp over diluted alcohol, to enable the gum to soak well into the animal, so as to protect the pigment from the balsam, in which it is soluble. I have specimens which have been mounted for more than seven years without showing any further change than the loss of a bluish tint, which occurs almost at once.

Most excellent transparent slides may be made with the so-called spider crabs, and these sometimes show well the

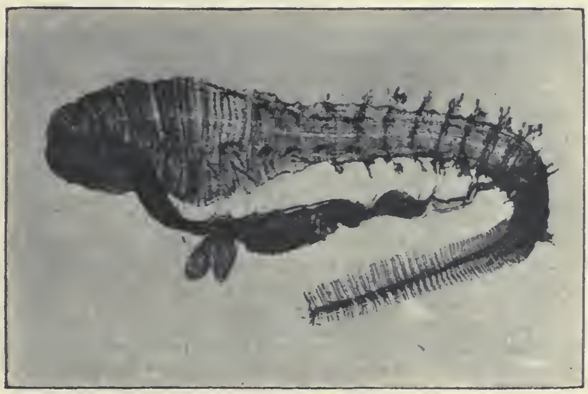

FIG. 2.—*Arenicola* partly dissected.

manner in which they are covered with a growth of sertularians, sponges, ascidians, &c. The animal is properly arranged on the glass, and at first gentle, and afterwards stronger, pressure applied, using waxed paper and glass covered with flannel; by which means the whole may be pressed flat without material distortion. The body and legs may indeed be made a little wider than natural, but this is to a great extent counteracted by lateral shrinking. At all events the general results are extremely good, and the muscles in the legs well seen.

Various species of Mollusca can be prepared so as to show their general anatomy by dissolving away the shell with hydrochloric acid in diluted alcohol. The organic matter of the shell retains the natural form, and shows the attachment of the various parts of the animal, which may be stained or not according to circumstances. Judging from what I have done, it will be possible to prepare instructive slides from the shells alone of some species, by dissolving away the carbonate of lime and mounting the membranous residue, which retains the natural form and much of the colour.

When first I attempted to mount Medusæ as lantern-slides, I looked upon them as most unpromising, and never imagined that it would be possible to prepare such specimens as I now possess. The first step must be to dissolve out all the included salt. For some years I used to put the newly caught specimens of *Aurelia* into methylic alcohol, diluted with half its bulk of fresh water, and after leaving them in for some hours, with occasional movement so as to prevent adhesion to the glass, they were digested over and over again with fresh diluted alcohol. Specimens so prepared are so colourless and transparent that little of the general structure can be seen, but if kept many months in alcohol they turn somewhat brown-yellow and show their structure moderately well. On the whole it is, however, better to stain them. I have experimented with a great variety of colouring-matters, but find that the best are tincture of madder, Beale's carmine, methylene-blue, port wine, and tincture of galls. The canal-system and the general structure are well seen when Beale's carmine is used, but the colour is unnaturally bright, whereas the colour of madder is more in harmony with nature. Methylene-blue gives good results with fresh specimens, but does not stain those which have been kept long in alcohol.

Though I have many splendid specimens prepared as described, my last year's experience shows that, at all events for some Medusæ, a 4 per cent. solution of formic aldehyde is far better than alcohol. Into this the newly-caught animals were at once put, and it was subsequently used to dissolve cut the salt. The superiority of this over alcohol is that Medusæ retain their form almost unaltered, and the most delicate parts can be moved about and arranged without fear of tearing. The only serious objection is that the very delicate fringe of *Aurelia* may be too rigid to be properly extended. No such objection exists in the case of *Cyanæa* or *Chrysaora*; and *Cyanæa* may be stained so as to be of nearly the natural colour, which is other-

FIG. 3.—*Aurelia* stained with carmine.

wise lost. In Fig. 3, I give an illustration of an *Aurelia* stained with carmine when in a 4 per cent. solution of formalin to which a little sulphurous acid was added.

In mounting Medusæ some special methods are necessary. Having removed the salt and stained the specimen as thought desirable, the lantern-slide glass is put into one of the usual developing dishes, and the animal floated out, and to some extent properly arranged, when under the liquid. The specimen may then be half an inch thick in the centre. No attempt should be made to dry it at once, since the greater part of the included liquid usually diffuses out, and nearly the whole can be drained off by keeping the slide inclined and covered up so as not to dry. In some cases the liquid passes off badly, but comes off rapidly, if a solution of gum is spread over the animal. As the edge dries, it should be covered with a strong clear solution of gum to which a little glycerine has been added to make it less brittle when dry, and this process continued until the whole specimen has been covered with gum. It should then be kept for some days in a wet state, so that the gum may soak well in, and any small bubbles not easily removed mechanically may disappear by absorption. At first I used to keep the specimens in a developing dish over a little water, covered up with a closely-fitting plate of glass, but sometimes in the course of a single day they became coated with a long growth of mould.

If, however, instead of water they are kept over alcohol diluted with an equal volume of water, they may remain wet for weeks, without any such growth of mould or such alteration in the gum as is produced by the action of stronger alcohol. It is very desirable not to finally dry too quickly, but, as it were, to anneal the specimens; since contraction may give rise to sufficient tension to cause them to crack and scale off from the glass.

I must now consider cases in which it is desirable to get rid of part of the colouring-matter, either natural or developed on keeping. Diluted sulphurous acid is very useful for this purpose, and remarkable results can be obtained with small fishes. If plaice about 2¼ inches long are kept in alcohol and then for a few weeks in diluted sulphurous acid, the earthy matter of the bones is dissolved out and only cartilage left; the general colour is reduced, and the thickness diminished; but strange to say, the arteries and enclosed blood are so little altered that when the specimens are mounted the aorta and branching arteries are well seen over the whole animal, as shown in Fig. 4, which, however, fails to show the more minute arteries, quite visible in the original.

Having duly prepared the dried animals, it may not be convenient to mount them at once in Canada balsam, especially when living on a yacht. They may then be kept in tin boxes with flannel which has been well dried at a fire, so as to absorb any moisture that may be in the air. When thus kept, even for many months, they usually do not undergo any sensible changes and do not go mouldy.

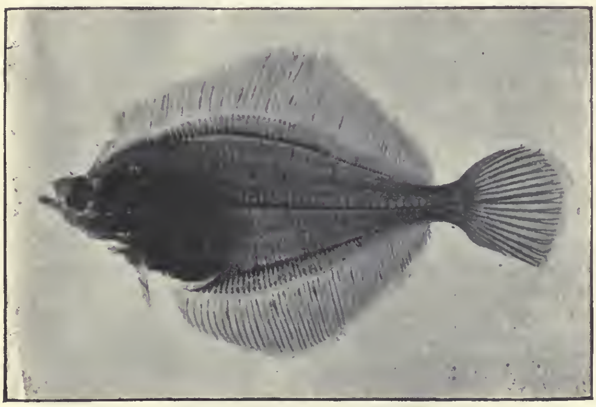

FIG. 4.—Plaice treated with sulphurous acid.

I must now conclude by describing the methods employed when finally mounting the specimens in Canada balsam. At the four corners of the glass should be gummed small pieces of blackened cardboard, of such a thickness that the cover-glass will just clear the object and not rock. The glass with the animal should be kept for a short or longer time in benzole; and, in the meanwhile, the cover-glass should be warmed on a suitable stand over a small burner, and a fair quantity of liquid balsam placed in the centre. The glass with the animal is then taken out of the benzole, and carefully placed over the balsam, so as to catch up as few bubbles as possible, the benzole causing the greater part to burst and disappear. If too little balsam has been used, more is easily run in between the glasses; and if only a few bubbles have been caught up, they soon disappear. If there are more than desirable, they can be got rid of by keeping the slide slightly inclined until they rise to one edge and can be removed. After keeping cold for a few days, for the balsam to harden the edges, it should be bound round with thin paper of the best quality, made thoroughly wet with gum. When this dries, contraction may squeeze out some superfluous balsam. This paper should then be varnished, and finally strips of good black paper should be *glued* well round the whole. All possible care should be used to enclose the balsam thoroughly, so as to avoid its turning yellow, and to prevent leakage, when the slide becomes warm in the lantern.

I have, however, had scarcely any trouble from this cause, since I have so completely fastened it in that the glasses or binding yield sufficiently. I may also say that though many of my slides have now been made for more than seven years, I have not observed any deterioration, but, on the contrary, many have greatly improved owing to the balsam having more completely penetrated into the tissues, and the included air disappeared. When this has taken place, the specimens are far more transparent and show their structure far better than the living or dead animals. Nearly all my slides have been kept in the dark, but some have been kept about the same time in a strong light at the Sheffield Public Museum, Weston Park, and, as far as can be judged, have not faded, even when imperfectly mounted. H. C. SORBY.

OUR MINERAL WEALTH.

IT would be difficult to conceive of a more concise and clearly expounded compilation of statistics and general information regarding mines and mining than that presented in the Third Annual Report upon the Mineral Industry of the United Kingdom of Great Britain and Ireland, which has been issued by the Home Office in the form of a Blue Book for the year 1896. The volume before us is a synoptical review of the condition of our own mineral industry, as well as that of other countries, which reflects unbounded credit upon its author, Dr. Le Neve Foster, and those who have assisted him in the work. It is divided into six parts, under the respective titles of persons employed, output, accidents, prosecutions, general remarks, and mineral statistics of the Colonies and foreign countries. It contains, in addition, nineteen appendices, and concludes with an exhaustive index.

The statistics for the United Kingdom distinguish between mines or underground workings and quarries or open workings; and the same figures are marshalled again and again under different aspects, so as to show their varying significance when coalfield is compared with coalfield, inspection district with inspection district, and county with county.

The first four parts include sixty-nine tables, in which the various classes of information susceptible of being so dealt with are compared with each other and with the corresponding figures for the year 1895. These are followed by six diagrams, on which are shown by means of curves, extending from 1851 to 1896 inclusive, the yearly variations in the numbers of persons employed above and below ground; the output and export of coal; output, export, and import of iron ore; deaths due to accidents generally; deaths from accidents, arranged in five distinct classes (explosions, falls of ground, in shafts, miscellaneous, and on surface); and the average quinquennial death-rate per 1000 persons employed, classified in the same way as in the last case. In Part iii. short descriptions are given of the circumstances under which the most important accidents of the year occurred; and throughout the volume many pertinent remarks are made, which serve to throw light upon the construction and meaning of the tables, point to the conclusions which they justify, and infer the lessons that are to be learnt from their perusal.

Turning now to a consideration of the subject-matter, we find that, taken altogether, there were 725,803 persons employed in or about mines during the year under review—576,325 working in the mines, and 194,478, including 5114 females, working on the surface. Of these numbers 678,690 were employed at 3260 coal mines, 16,819 at 136 iron mines, and 30,294 at 720 other mines. In addition to this there were 112,829 persons employed at 7758 quarries.

The quantity and value of the principal classes of minerals mined and quarried were as follows:—

Name of mineral.	Quantity.	Value at the mines or quarries.
	Tons.	£
Clays	11,341,782	1,442,069
Coal	195,361,260	57,190,147
Iron ore	13,700,764	3,150,424
Limestone ...	11,011,350	1,215,604
Sandstone ...	4,507,745	1,417,985
Slates and slabs ...	586,933	1,338,256

The total value of all the minerals worked in the kingdom was 69,088,366*l.*, from which it will be seen that the value of the coal alone was practically five-sixths of the whole amount.

The number of separate accidents in mines was 886, involving the loss of 1065 lives, of which 147 were the victims of four explosions of fire-damp or coal-dust. The number of separate accidents in quarries was 117, in which 124 lives were lost.

A comparative table showing the death-rates from mining and quarrying accidents in different countries per 1000 persons employed, brings out some remarkable facts. Taking the column which represents the total for underground and surface for the year 1896, or in the absence of the figures for 1896 those of 1895, we find the following rates for the coal mines in some of the principal coal-producing countries of the world:—

Belgium	1·14
France (1895)	1·19
German Empire	2·57
Russia (1894)	1·29
United Kingdom	1·48
United States (1895):—	
Colorado	3·75
Illinois	1·94
Indiana	2·70
Indian Territory	1·64
Kentucky	1·02
Missouri	2·07
New Mexico	16·88
Ohio	2·11
Pennsylvania:—	
Anthracite	2·924
Bituminous	1·825
Utah	1·50

According to M. Louis Lacombe, who compared the death-rates from accidents in mines in quinquennial periods, the last of which was 1890 to 1895, the ratios are as follows:—

Russia 2·90, Belgium 2·38, England 2·18, France 1·37.

The death-rate from accidents to railway servants in the United Kingdom for the year 1896 is given as 1·01 per 1000. The category includes such classes as carmen 0·47, clerks 0·17, mechanics 0·33, and signalmen 0·55, whose occupations are not by any means dangerous. On the other hand, the death-rate amongst those who have to do with coupling and uncoupling and making up the trains is infinitely more serious, such as shunters 4·94, yardsmen, 3·27, guards and brakesmen of goods trains 3·03. The highest of these figures pales before those applicable to sailing ships, amongst which we find:—

British sailing ships (1896)	12·9
German ,, ,, (1893)	15·8

These figures prove conclusively that the miner's calling, when brought into comparison with some other kinds of employment, is not of such a dangerous nature as is generally supposed. As having a bearing upon this question, however, it may be stated that one of the most gratifying features of the report is the curve given on Plate 4, which shows the death-rate per 1000 persons employed underground in coal-mines to have been reduced from the appalling figure of 5·5 in 1851 to 1·62 in 1896. This result—upon the attainment of which the Home Office, the Inspectors of Mines, and the mining community generally may well be congratulated—is undoubtedly due to the efforts that have been made by means of legislation and inspection to remove the causes which formerly led to such a lamentable loss of life. The loss of 147 lives in four great explosions in the year 1896 is a black spot in the record which ought never to have been there. I am glad to observe that the year 1897 has been entirely free from anything of the same kind, and I feel confident that if the new regulations regarding the watering of dusty places, and the use of explosives are attended to, or enforced with unflinching severity, we shall have seen the very last of such affronts to humanity and common sense.

The fines imposed upon owners and managers of mines for contraventions of the Mines Acts amounted to the insignificant sum of 258*l.* 13*s.* 9*d.*, while the workmen for similar offences paid 459*l.* 6*s.* 8*d.*

The outputs of coal from a few of the principal coal-producing countries were as follows:—

		Metric tons.
1895	Austria, brown coal	18,389,147
	,, coal	9,722,679
1896	Belgium	21,252,370
1895	France, brown coal	437,000
	,, coal	26,109,893
1896	German Empire, brown coal	26,797,880
	,, ,, coal	85,639,861
1896	Great Britain	198,496,339
1895	Russia, anthracite	709,718
	,, coal	8,369,420
1895	United States, anthracite	52,616,149
	,, ,, coal	122,577,246

From these figures, with which I propose to bring this short and necessarily fragmentary notice to a close, it will be seen that this country still heads the list; but the United States are quickly overtaking us, and will, no doubt, come into the first position in the course of the next few years.

W. GALLOWAY.

CALCIUM CARBIDE AND ACETYLENE.

AT the meeting of Institution of Civil Engineers on March 15, a paper on "Calcium Carbide and Acetylene" was read by Mr. Henry Fowler, and is here abstracted.

Acetylene was first isolated by E. Davy in 1837 from potassium carbide, a by-product of Sir H. Davy's method of manufacturing potassium. In the middle of the century Berthelot investigated its properties, and Wöhler produced it from calcium carbide. During the past few years it has assumed commercial importance owing to the development of the electric furnace, in which calcium carbide can be readily produced from lime and carbon. The furnaces used consist essentially of crucibles with carbon rods forming the positive electrode and a bottom plate lined with carbon for the negative. In the more recent furnaces these crucibles are mounted on small trollies so that they may be run out of the furnace when ready and a fresh one inserted without loss of time. The carbide formed is a hard, dense substance of reddish colour, unacted upon by most of the ordinary reagents. It is, however, rapidly decomposed by water into acetylene and lime, giving 5·9 cubic feet of acetylene, at a temperature of 60° F. and a pressure of 30 inches of mercury, per 1 lb. of carbide. As the power required theoretically to produce 1 lb. of calcium carbide in an electric furnace is more than 2 H.P. hours, its manufacture is at present restricted to localities where power is cheap, as for instance where water-power is available.

Acetylene is a colourless gas with an intensely penetrating odour, and is slightly soluble in water, and extremely so in some other fluids. It is endothermic, giving 407 calories per cubic foot, whereas theoretically its value is 336·5 calories. As an illuminant it gives the most brilliant light of all gases, 5 cubic feet per hour under suitable conditions giving 240 candle-power. For small consumptions, however, this value is not obtained, and ordinary burners after a short time became clogged with soot. The latter defect can be overcome by the use of an injector burner, which, however, requires a higher pressure. Various diluents have been suggested, but have not been tried on a practical scale. The flame has a high actinic value, and causes light colours to appear lighter, and dark colours darker than when exposed to sunlight. The gas, when inhaled, combines with the hæmoglobin and renders the blood incapable of taking up oxygen, and thus causing suffocation. It has, however, been shown that it is no more dangerous in this respect than coal gas.

Acetylene unites with copper, in the presence of moisture and ammonia, forming copper acetylide, and this when in a dry state is violently explosive. Silver is similarly acted upon.

Owing to the difficulty of obtaining the materials used in producing calcium carbide in a pure state, phosphoretted and sulphuretted hydrogen and ammonia are often found in the gas, and these should be removed by passing the gas through water and an acidified solution of a metallic salt. Nearly all proportions of air and acetylene are explosive, the gas itself being decomposed at 780° C. At higher pressures than 2 atmospheres, if this temperature is attained by a part of the gas, it is communicated throughout the whole mass and a violent explosion occurs, which causes the pressure to rise to eleven times the initial pressure; but owing to cooling by radiation, &c., this is not reached in practice. Acetylene can be readily liquefied, having a critical temperature of 37° C. and pressure of 68

atmospheres. The resulting liquid is very light and has a high coefficient of expansion. Although this is a convenient method of storing a large quantity of gas in small bulk, it is unsafe, because of the ease and violence with which it explodes. The gas is extremely soluble in acetone; it has been suggested that this property might be used for its storage, but it has been shown that acetylene does not, even when thus dissolved, lose all its explosive properties.

Numberless devices for generating acetylene have been invented; its application, however, is more dependent upon the cost than upon the apparatus used in the manufacture. With calcium carbide at 16*l.* per ton, it can compete with coal gas at 2*s.* 6*d.* per thousand cubic feet, when flat flames are used for the latter, and a light of not less than 30 candles is required. This renders the gas peculiarly suited for buildings in which coal gas is not obtainable. It has been used for lighting a station on the Great Southern and Western Railway of Ireland, and at the Salford Docks of the Manchester Ship Canal. In the latter case, special portable generators are used which can be carried to any part of the docks, and which may be placed on the quay side and the gas led away to lamps placed in the holds of vessels. Amongst many other uses suggested are the lighting of lighthouses, lightships, buoys, military signals, &c., as a standard of light, &c. The price prevents its use for gas-engine driving. This reason also prohibits its use as an enricher of coal gas, as with low percentages the increase is not above 1 candle-power for 1 per cent. of acetylene. With "blue" water-gas it is even less applicable, as more than 10 per cent is required before any illumination is obtained. Methane and nitrogen are claimed to carry the gas without affecting its illuminating power.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. R. T. GLAZEBROOK, F.R.S., has accepted the post of Principal of University College, Liverpool.

DR. H. W. M. TIMS has been appointed professor of zoology in Bedford College, in succession to Dr. Benham.

MR. AMOS R. ENO, the New York multi-millionaire, who died a few weeks ago, left 50,000 dollars to Amherst College.

MISS CATHERINE W. BRUCE, of New York, will give to the Yerkes Observatory, Chicago University, a photographic telescope of 10 inches aperture and 60 inches focal length.

THE bequest by Catherine M. Garcelon, of California, to Bowdoin College, Maine, amounting to several hundred thousand dollars, has been confirmed by the Supreme Court of the United States.

THE proposal to establish a chair of Anthropology and Anatomy, and also a chair of Physiology, in the University of St. Andrews, has been sanctioned by the University Court, and a scheme will be prepared.

THE proposal to create a special degree of Doctor of the University of Paris (as distinct from doctor of a particular faculty) has been approved by the Superior Council of Public Instruction, and will shortly be carried into effect.

AMONG the degrees conferred at the annual graduation ceremony of the University of St. Andrews on March 25, was the honorary degree of LL.D., upon Prof. G. B. Howes, F.R.S., and the degree of D.Sc. upon Mr. A. T. Masterman.

THE recent decision of the Government, abolishing building grants from Imperial funds to schools and institutions under the Department of Science and Art, has created dissatisfaction. A joint deputation of the County Councils Association, the Association of Municipal Corporations, and the Association of Technical Institutions waited upon Sir John Gorst at the Privy Council last week to point out the inconvenience caused by the withdrawal of the grants without previous notice; and Sir John Gorst promised to bring the views of the deputation before the President of the Council.

SCIENTIFIC SERIALS.

THE *Journal of Electricity*, published in San Francisco, contains accounts of several large schemes for the electrical transmission of power in California. In one of these the water furnishing the power required for lighting Blue Lakes City, and several neighbouring townships, is conducted from the Blue Lakes, situated near the summit of the Sierra Nevada Mountains; while another installation at Bakersfield derives its power from the Kern River canyon. The "Wild West" is certainly making great strides in the practical applications of electricity.

IN the current number of the *Physical Review*, Miss Isabelle Stone writes on the electric resistance of thin films; Mr. Edward B. Rosa describes a new form of electric curve-tracer; and Mr. C. H. Wind propounds a new theory of magneto-optic phenomena, the paper being a translation of one published by the Amsterdam Academy of Science.—Prof. C. Barus describes a method of obtaining pores or capillary canals of specified diameter; and Mr. C. P. Matthews discusses the methods of measuring mean horizontal candle-power of glow lamps, considering more especially the plan of rapidly whirling the lamp.

THE latest number of the *Mathematical Gazette*, published under the auspices of the Mathematical Association, contains papers by Mr. E. Budden, on the conic through any five points; by Prof. Lloyd Tanner, on a class of algebraic functions; and a notice, by Dr. F. S. Macaulay, of an article by Miss C. A. Scott on Cayley's theory of the absolute. The functions to which Prof. Tanner's paper refers are those which involve only the differences of their arguments, and to which the same *diaphoric* was given by Cayley; and the object of the note is to suggest that an elementary discussion of these functions would be a valuable addition to the usual school course in algebra.

Symons's Monthly Meteorological Magazine, March.—West of England snowstorm, February 21. The fall commenced, roughly speaking, about 5h. p.m., and lasted until noon on the 22nd. The heaviest storms occurred in Hants, Dorset, Devon and Somerset. The fall reached, or exceeded, 12 inches over the area contained between two lines, the northern one running about E.S.E. from Watchet, through Yeovil to Lymington, and the southern one from Portlock, through Tiverton to Bridport; say about sixty by twenty miles. The greatest depth, about 24 inches, occurred nearly centrally in this belt, between Milverton and Crewkerne.—Results of meteorological observations at Camden Square for forty years (for February). It is interesting to note the exceptional temperature and rainfall of last February in connection with the mean of 1858–97, at Camden Square (N.W. London): maximum temperature in 1898, 56°·2; minimum, 24°·3. Mean of all highest maxima of previous forty years, 55°·2; mean of all lowest minima, 24°·1. Rainfall in 1898, 1·08 inches; mean of forty years, 1·61 inches.

THE *Journal de Physique* for March contains papers on the following subjects:—On the magnetic torsion of iron and steel, by M. G. Moreau, in which the following laws are established: (1) at a point of a twisted wire outside the magnetic field the magnetic torsion is proportional to the torsion of the wire, to the square of the intensity of the field if the latter is weak, and independent of the diameter of the wire; (2) for points situated on different sides of the field the magnetic torsion has equal and opposite values if the ends of the wire are symmetrically placed with regard to the field; (3) along the length of the wire the torsion increases in proportion to the distance from the nearest end; it attains a maximum at the edge of the field, and vanishes at points inside the latter. The field in question is supposed to be a uniform field bounded by two parallel planes, beyond which the magnetic force vanishes.—M. Marage contributes a paper on ear-trumpets studied by the use of Koenig's flames.—M. G. Weiss describes an ingenious method, due to Hermann, of expanding any periodic curve in Fourier's series up to the first forty terms. The curve being drawn, forty equidistant ordinates are taken and measured, and corresponding to each ordinate a series of products is obtained from a table prepared by Hermann; and these are entered in columns on *quadrillé* paper. Finally a series of perforated cards are placed on the table thus formed; and to read off any coefficient in the expansion it is only necessary to algebraically sum the numbers seen through the openings in the corresponding card.—M. G. Charpy discusses entectic alloys, his paper being illustrated by figures showing their microscopic structure.—M. Gerrit Bakker, writing on perfect gases, gives a simple mathematical proof of the theorem that of the three characteristic laws of such gases, Boyle's, Charles's, and Joule's; any one is deducible from the other two.

SOCIETIES AND ACADEMIES

LONDON.

Physical Society, March 25.—Mr. Shelford Bidwell, President, in the chair.—Mr. A. A. Campbell Swinton read a paper and showed experiments upon the circulation of gaseous matter in a Crookes' tube. The stream-lines within a Crookes' tube are investigated by observing the direction and speed of rotation of a mica radiometer-mill, mounted on a sliding-rod, so that it can be moved along a line at right angles to the line joining the electrodes. The axis of the mill is at right angles to both these lines. If the mill is adjusted to a position between the flat plate and the cup electrodes, with its axis just sufficiently low to prevent equal and opposite simultaneous actions on the top and bottom vanes, it rotates always in the direction indicating a stream from kathode to anode. The speed is greater when the flat plate is the kathode. If, however, the mill is now moved below this line, a point is reached at which rotation ceases, and below this neutral point the rotation is suddenly reversed. Reversal is only to be observed with high degrees of exhaustion; the rotation is never so rapid here as in the first position. The mill rotates, and the reversal may be observed, whether cup or plate is made kathode, and the direction of rotation below the neutral point is always opposite to that in the position above it. A small Wimshurst machine is as effective as an induction coil in producing these effects. The experiments are intended to establish the existence, at high degrees of exhaustion, of a true anode-stream, *i.e.* a stream that travels from anode to kathode just in the same manner as the kathode-stream flows from kathode to anode. This anode-stream is charged positively; it is exterior to the kathode-stream; its velocity is less than that of the kathode-stream, but its velocity increases as the vacuum is improved. It seems probable that, in high vacua, some portion of the positive electricity passing through the tube, is carried by the positively charged atoms or particles that constitute the anode-stream. At lower degrees of exhaustion, the discharge passes through the tube chiefly by interchange of charges from molecule to molecule—a Grothüs chain. At very high vacua, however, when the mean free path is considerable, there may be to some extent a regular and complete circulation of positive and negative atoms, some of which pass from anode to kathode, and *vice versâ*, and deliver up their charges, not by interchange, but by direct convection, to the electrodes of opposite sign. Prof. Boys said he did not feel altogether convinced by the experiments, that the rotation of the mill was due to simple mechanical motion of the particles of matter between the electrodes. The weight of air left in the tube at such high degrees of exhaustion was extremely small; it was difficult to realise that its impact could produce the sudden mechanical effect observed at the moment of the reversal of the rotation of the mill. Mr. Wimshurst thought it important to keep in mind the existence of mercury-vapour in the tube. He also referred to some experiments in which a bar of metal was used to explore a focus-tube, by observation of the changes of luminosity produced in different positions. Dr. Chree said that if the rotations of the mill could be shown to indicate a velocity of the particles, of the same order as that observed in Crookes' experiments, it was safe to assume the existence of a similar cause. This might be important in deciding as to the general truth of the bombardment theory of Crookes. He asked whether the rotation had been investigated within the dark space around the kathode. Mr. Appleyard suggested that in tracing the cause of the rotation it would lead to simpler results if the vanes of the mill were made of some light conducting substance. Mica introduced difficulties owing to its retention of the charges. Prof. Boys pointed out that this could be done by gilding the mica. Mr. Campbell Swinton, in reply, said that the objection raised by Prof. Boys to the mechanical theory of the rotation would apply equally to the whole theory of electro-radiometry, including the case of the mill used originally by Crookes in the direct path of the kathode-stream. But it must be remembered that although the mass of matter present within the tube was very small, its velocity was proportionately great, it was of the order of 9000 kilometres per second; hence the contained matter might be conceived as capable of producing the observed acceleration, and Crookes' bombardment theory might with safety be adopted as a good working hypothesis. In the tubes used for these experiments, the exhaustion was carried so high that the negative dark space appeared to fill the whole tube. He had, so far, only tried mica for the vanes, but he thought it would be important to observe the result with a substance that did not retain the charges.—Mr. A. Stansfield then read a paper on thermo-electric pyrometers. In obtaining photographic records of the readings of thermo-electric pyrometers, the range of measurement is limited by the size of the photographic plate. For long ranges of temperature, the sensitiveness of the galvanometer must therefore be small. When it is desired to examine the temperature changes in detail—as, for instance, at the melting-points and freezing-points of metals—it is necessary to employ some device for giving a more open scale for the short temperature ranges that include those particular points. For this purpose two galvanometers are arranged in parallel, and so that they have their deflections recorded on the same photographic plate. The less sensitive galvanometer covers the entire range of temperature throughout an observation; the other is brought into use for magnifying special portions of the range. In this latter case, part of the electromotive force of the thermo-couple is compensated by an opposing electromotive force, applied at two points of the circuit, from a battery of Clark cells in series with a high resistance. The recording apparatus consists of a photographic plate mounted on a float that rises steadily when water is admitted into a cylinder. The source of light is a glow-lamp, enclosed in a wooden box. A brass tube, with a rectangular diaphragm at the end nearest the lamp, cuts off all light except that from a selected piece of vertical filament. Light from this filament is reflected by the plane galvanometer-mirror, and is focussed upon the photographic plate by a lens in front of the galvanometer; this method was suggested by Prof. Boys. The "cold" junctions of the thermo-couple are both inserted into a hypsometer. Very serious discrepancies exist between the indications of couples having nominally the same composition; they are too great to be attributed to accidental differences in the constitution of the alloys. Although with platinum alloys, coupled with platinum, 10 per cent. of iridium gives a more powerful couple than 10 per cent. of pure rhodium, the partial substitution of iridium for rhodium very considerably lowers its thermo-electric power. This result suggests that the change in the thermo-electric power of a metal depends upon the extent to which it is saturated with the alloying metal; thus 10 per cent. either of rhodium or iridium would, *per se*, more completely saturate the platinum than would 10 per cent. of a mixture of the two metals. The author discusses a series of curves derived from his experiments. He concludes that, thermo-electrically, there may be two classes of metals: (1) the ordinary metals, for which the curve representing the first differential of electromotive force with respect to temperature is a straight line, and (2) the platinum metals, together with a few, such as nickel and cobalt, for which the curve of this differential multiplied by the absolute temperature is a straight line. Dr. Chree discussed the curves, and asked how far stirring affected the results; he was inclined to think that stirring was a mistake. Mr. A. Campbell inquired whether the galvanometer kept its zero sufficiently well throughout the tests. Mr. Stansfield, in reply, said he had also come to the conclusion that stirring was a mistake; and it was a mistake to use a large quantity of metal. The pyrometers were sensitive to about a tenth of a Centigrade degree. He had experienced great difficulty with the zero of the galvanometer.—The President proposed votes of thanks to the authors, and the meeting adjourned until April 22.

Chemical Society, March 17.—Prof. Dewar, President, in the chair.—The following papers were read:—The reduction of bromic acid and the law of mass action, by Miss W. Judson and J. W. Walker. The reduction of bromic acid by hydrobromic acid constitutes a bimolecular reaction in presence of much sulphuric acid, and a tetramolecular reaction in absence of sulphuric acid.—The action of ferric chloride on the ethereal salts of ketone acids, by R. S. Morrell and J. M. Crofts. In dry ethereal solution, ferric chloride acts on ethylic ketophenylparaconate with production of a substance, $FeCl_2C_{13}H_{11}O_5$, which is decomposed by water yielding the basic ferric salt of ethylic phenylparaconate, $Fe(OH)(C_{13}H_{11}O_5)_2$; analogous results are obtained with the ethylic salt of the lactone of oxalcitric acid.—Note on the volatility of sulphur, by T. C. Porter. Sulphur sublimes rapidly at 100° in a vacuum.—Cannabinol, by T. B. Wood, W. T. N. Spivey and T. H. Easterfield. Cannabinol, the toxic resinous constituent of Indian hemp, boils at 400°, and its vapour density points to the molecular composition $C_{18}H_{24}O_2$;

it contains one hydroxyl-group, and is converted by prolonged boiling into a hydrocarbon of the composition $C_{10}H_{16}$.—Contributions to the chemistry of thorium, by B. Brauner. The author has investigated the properties of a new salt, ammonium thoroxalate, $Th(C_2O_4)_2, 2(NH_4)_2C_2O_4, 7H_2O$, and has obtained a simple method of purifying thorium compounds by aid of this salt; it is shown that the tendency to form complex oxalates amongst the rare earths is inversely proportional to the basicity of the earth.—On the atomic weight of thorium, by B. Brauner. From experiments made on ammonium thoroxalate, the author deduces the atomic weight of thorium as $Th = 232 \cdot 44$, a result agreeing with the number obtained by Krüss and Nilson.—On the compound nature of cerium, by B. Brauner. From experiments on fractional crystallisation, the author concludes that cerium is associated with an element which possibly has the atomic weight of 110; another earth of lower atomic weight is perhaps present.—On praseodidymium and neodidymium, by B. Brauner. The author contributes a quantity of experimental data concerning praseodidymium and neodidymium, and considers that the eighth series of the periodic system may assume the form

Cs	Ba	La	Ce	Pr	Nd
133	137·4	138·2	139·7	141	143·6.

—Action of ammonia and substituted ammonias on acetylurethane, by G. Young and E. Clark. Ammonia and substituted ammonias react with acetylurethane principally in accordance with the equation

$$MeCO.NH \,.\, CO_2Et + NH_2R = MeCO \,.\, NH \,.\, CONHR + EtOH,$$

but secondary reactions occur under certain conditions.—Formation of oxytriazoles from semicarbazides, by G. Young and B. M. Stockwell. This paper describes the formation of oxytriazoles according to the equation

$$NHR.NH.CO.NH_2 + PhCHO + O = RPh.C_2N_3OH + 2H_2O,$$

in which R is an aromatic radicle.—Formation of $\alpha\alpha'$-dihydroxypyridine, by S. Ruhemann. $\alpha\alpha'$-Dihydroxypyridine hydrochloride is formed on boiling ethylic $\alpha\alpha'$-dihydroxydinicotinate with concentrated hydrochloric acid.—Position-isomerism and optical activity; the comparative rotatory powers of diethylic monobenzoyl and monotoluyl tartrates, by P. Frankland and J. McCrae.—The action of di-isocyanates upon amido-compounds, by H. L. Snape.—The action of alkyl iodides on silver malate and on silver lactate, by T. Purdie and G. D. Lander. The abnormally high optical activity of the ethereal malates and lactates prepared by the silver salt method is due to the simultaneous production of ethereal salts of alkyloxysuccinic and alkyloxypropionic acids respectively.—On the optical rotations of methyl and ethyl tartrates, by J. W. Rodger and J. S. S. Brame.

Anthropological Institute, March 8.—Mr. F. W. Rudler, President, in the chair.—The Hon. David W. Carnegie exhibited and described a large collection of objects of ethnological interest, which he had recently brought from Western Australia. He gave a description of the natives met with in his remarkable journey across the great sandy desert of the interior, between Coolgardie and Kimberley. Some of the men, notwithstanding the miserable character of their surroundings, were upwards of six feet in stature.—Mr. Robert Etheridge, curator of the Australian Museum at Sydney, sent for exhibition a large series of photographs of dilly baskets from North Australia. Many of these objects were highly ornate, and offered curious illustrations of aboriginal decorative art.—A paper on the folk-lore of the native Australians, by Mr. W. Dunlop, was read by Mr. T. V. Holmes. Most of the legends cited were taken down from the lips of the natives nearly half a century ago.

Entomological Society, March 16.—Mr. R. McLachlan, F.R.S., Vice-President and Treasurer, in the chair.—Mr. Champion exhibited specimens of *Acanthia inodora*, A. Dugès, from Guanajuato, Mexico. This insect, a congener with the common bed-bug, was found in fowl-houses, where it attacked poultry.—Mr. Wainwright exhibited a locust found alive in broccoli at Birmingham. The insect was identified by Mr. Burr as *Acridium ægyptium*.—Mr. Tutt showed a series of captured examples of *Calligenia miniata*, varying in colour and the amount of black markings, one example being a clear yellow and another orange.—The Secretary exhibited part of a series of holograph letters, &c., which he had discovered among old papers in the Society's library, including communications from Kirby, Spence, Darwin, Hope, Yarrell, and many other entomologists.—A paper by Mr. E. E. Green, of Punduluoya, Ceylon, entitled "Further notes on *Dyscritina*, Westwood," was read, and illustrated by specimens and drawings.—The author discovered two distinct species of *Dyscritina*, which he was able to keep in captivity, and rear from the early larval stage to that of the imago.—Dr. Chapman read a paper entitled "Some remarks on *Heterogyna penella*," giving a full account of its life-history.

MANCHESTER.

Literary and Philosophical Society, March 22.—Mr. J. Cosmo Melvill, President, in the chair.—The President read a description and exhibited two specimens of *Strombus* (*Conomurex*) *belutschiensis*, just discovered by Mr. F. W. Townsend off the Mekran coast of Beluchistan, having been dredged at seven fathoms on a sandy and muddy bottom. This is a remarkable find, as it is nearly fifty years since any new species of this genus has come to light. It is most akin to *S. mauritianus*, Lam., but differs in several marked particulars.—Prof. Hickson communicated a paper by Miss E. M. Pratt, entitled "Contributions to our knowledge of the Marine Fauna of the Falkland Islands." The Manchester Museum received last summer a number of marine animals collected on the shores of one of the Falkland Islands by Miss Blake. As they were nearly all in an excellent state of preservation, the author was able to identify them, and to compare this common shore fauna, as a whole, with that of other temperate regions in the northern and southern hemispheres. The bearing of the facts of the geographical distribution of the species identified by Miss Pratt, upon Murray's theory of the bipolar distribution of marine organisms, was also indicated.

DUBLIN.

Royal Dublin Society, February 16.—Sir Howard Grubb, F.R.S., in the chair.—Prof. J. Emerson Reynolds, F.R.S., and Mr. Emil A. Werner made a communication on Goodwin's system of generating and using acetylene gas for illuminating purposes.—Prof. D. J. Cunningham, F.R.S., described the seventh cranial nerve in the orang, with illustrations by lantern projection.—Dr. W. E. Adeney and Mr. James Carson described the method they have followed in mounting the 21·5 feet concave Rowland diffraction grating, which has recently been acquired by the Royal University, Dublin.

EDINBURGH.

Mathematical Society, March 11.—Dr. Morgan, Vice-President, in the chair.—The following papers were read: An analysis of all the inconclusive votes possible with fifteen electors and three candidates, and a suggestion for a shortened table of five-figure logarithms, by Prof. Steggall; note on the centre of gravity of a circular arc, by Mr. John Dougall; on the wave surface generalised for space of *n* dimensions, Prof. Schoute.

PARIS.

Academy of Sciences, March 21.—M. Wolf in the chair.—Algebraic solutions of some questions concerning the indeterminate equations of the second degree of three terms, by M. de Jonquières.—Action of some reagents upon carbon monoxide, in view of its estimation in the air of towns, by M. Armand Gautier. A study of the various absorbents proposed for the estimation of carbonic oxide. Of these cuprous chloride and potassium permanganate react also with acetylene and ethylene; chromic acid is only partial in its action. A one per cent. solution of gold chloride gives an immediate precipitate with the pure gas, even in the cold, and forms a good qualitative test for CO mixed with air.—Observations of the sun, made at the Observatory of Lyons with the Brunner equatorial, during the fourth quarter of 1897, by M. J. Guillaume. Statistics referring to spots and faculæ are given.—New series of photographs of the complete chromosphere of the sun, by M. H. Deslandres.—On the singular transformations of Abelian functions, by M. G. Humbert.—On discontinuous functions capable of development in series of continuous functions, by M. R. Baire.—On the transformation of the X-rays by matter, by M. G. Sagnac. A metal upon

which X-rays from a vacuum tube are falling emits secondary radiations differing in penetrative power from the original rays, and also differing according to the nature of the reflective substance. Thus aluminium gives off secondary rays which are much more penetrating than those of zinc.—Some applications of photographic irradiation, by M. Ch. Féry. On the hypothesis that the upper portion of the sensitive plate when illuminated by a ray acts as a true secondary source for neighbouring portions of the film, the conclusion is drawn that the apparent width of the line due to halation ought to grow in arithmetical progression when the quantities of light increase in geometrical progression, and this conclusion was verified completely by experiment.—Remarks on the preceding communication, by M. A. Cornu. This research throws light upon the divergences obtained in different observatories in the measurement of stellar magnitudes by photographic observations, although part of the observed variation is probably due to aberrations of the mirror.—On a universal magnifier for use in photographic enlargements, by M. J. Carpentier.—Determination of the density of gases with very small volumes, by M. Th. Schlœsing, junr. A detailed description of the apparatus used for the determination of gaseous densities by the hydrostatic method, together with the results obtained for air, nitrogen, carbon dioxide and sulphur dioxide. The results are accurate to one part in a thousand.—On neodymium, by M. O. Boudouard. Neodymium forms a double sulphate with potassium, which is more soluble than the corresponding salt of praseodymium, the difference in solubility being sufficiently great to allow of a fairly rapid separation.—On the explosion of mixtures of marsh gas and air by the electric spark, by MM. H. Couriot and J. Meunier. To avoid explosion, it is necessary to join up the two points between which the spark is produced by a secondary conductor.—On the properties of the phosphorescent sulphide of strontium, by M. José Rodriguez Mourelo. —On the oxidation of some amido- and thio-amido-compounds, by M. Œchsner de Coninck. A study of the oxidation of acetamide, thio-urea, phenyl-urea, phenyl-thiourea, sarcosine, and carbamic ether by alkaline hypochlorite solution. —On the chlorine derivatives of phenyl carbonate, by M. E. Barral. By the action of chlorine in presence of iodine upon phenyl carbonate dissolved in carbon tetrachloride, the di-chlor-derivative, $CO(O.C_6H_4.Cl)_2$ is obtained.—On the cholesterins of the lower plants, by M. E. Gérard.—Study of the anatomy and histology of the rectum and rectal glands of the Orthoptera, by M. L. Bordas.—On the reserve material in *Ficaria ranunculoides*, by M. Leclerc du Sablon. Estimations of the reducing and non-reducing sugars, dextrin and starch in the tubers of *Ficaria* were made monthly, and the results expressed in curves.—The tectonic of the secondary and mountainous region comprised between the valleys of the Ouzom and Aspe (Basse-Pyrénées), by M. J. Seunes.—On the phyllogenic classification of the Lamellibranchs, by M. H. Douvillé.—On the visibility of the X-rays to certain young blind persons, by M. Foveau de Courmelles. Only nine out of two hundred subjects examined were able to distinguish when the Crookes' tube was or was not excited. No sensation was perceived by those totally blind, only those blind by a peripheral lesion, or having a vague perception of light, being sensitive to the X-rays.—Applications of radiography to the study of digital malformations, by MM. Albert Londe and Henry Meige.—Application of radiography to the study of a case of myxœdema; development of the osseous system under the influence of the thyroid treatment, by MM. Georges Gasne and Albert Londe.—Experimental paralysis under the influences of venoms, by MM. Charrin and Claude.—On the eruptions of Vesuvius, by M. E. Semmola.—Communication from the Directeur des Services de la Compagnie des Messageries Maritimes, concerning a Dugong captured in the Red Sea, of a species supposed to be extinct.

ST. LOUIS.

Academy of Science, February 21.—Dr. R. J. Terry exhibited a specimen of a cervical rib from a human subject, and discussed the occurrence of structural anomalies of this character.

March 7.—Prof. C. M. Woodward presented a paper embodying an analytical discussion of the efficiency of gearing under friction. Few works on applied mechanics, the speaker stated, give any discussion of the matter. Only spur wheels with epicycloidal and involute teeth were considered. For the sake of comparison, a table was produced giving the efficiency for different values of the coefficient of friction f, and for equal wheels and for the same number of teeth, 12, on each wheel.

Efficiency of Spur Wheels.

Equal wheels with 12 teeth each.

Kind ...	f 0·03	f 0·10	f 0·15	f 0·20	f 0·25
Epicycloidal	0·9915	0·9693	0·9514	0·9318	0·9103
Involute ...	0·9923	0·9746	0·9622	0·9501	0·9381

—Dr. Amand Ravold demonstrated the method, recently introduced by Hiss, of differentiating the typhoid bacillus from bacillus coli-communis, by the use of semi-solid acidulated media, in which, at blood temperature, the round colonies of the typhoid bacillus assume a peculiar fimbriated form of growth, because of the motility of the bacteria in the slightly yielding medium, which in most cases readily distinguishes them from the more whetstone-shaped colonies of the colon bacillus, which does not produce the peculiar fimbriation in plate cultures. In tube cultures in the same general medium, but prepared with a slighter acidity and somewhat less solidity, a uniform clouding of the entire tube, due to the swarming of the bacteria, was shown to be characteristic of the typhoid bacillus, while the colon bacillus was definitely confined to the immediate vicinity of the thrust. The media in both cases are made up without peptone. The formulæ are:—

For plate cultures.		For tube cultures.	
Agar ...	... 10 grams.	Agar ...	... 5 grams.
Gelatine ...	... 25 ,,	Gelatine ...	... 80 ,,
Beef extract	... 5 ,,	Beef extract	... 5 ,,
Glucose ...	... 10 ,,	Glucose ...	... 10 ,,
Salt ...	... 5 ,,	Salt ...	... 5 ,,
Normal acid	... 20 cc.	Normal acid	... 15 cc.
The whole increased to 1000 cc.		The whole increased to 1000 cc.	

The growth of the two species in question, on potato and in milk cultures with litmus, was also demonstrated.

AMSTERDAM.

Royal Academy of Sciences, February 26.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Schoute, Necrology of Dr. F. J. van den Berg (1833–1892), Professor of Mathematics at the Polytechnic School of Delft (1864–1884).—Mr. Muller, correspondent of the Academy in the Dutch East Indies, made a communication on the triangulation of Sumatra. When, on the completion of the triangulation of the "Government of the West Coast of Sumatra," the triangulation of South Sumatra was to be commenced, the intention was to start from the triangulation points, determined in 1868 and 1869 in the Lampong districts by the staff of the then Geographical Service. On inquiry being made towards the end of 1895 into the condition of the pillars erected on those points, they were all found to have disappeared, so that the staff of the Triangulation Brigade of the Topographical Service, appointed to carry out the triangulation of Sumatra, had to effect a new connection across the Strait of Sunda. The Langeiland–G. Radja Bara side of the Sumatra chain was therefore connected by means of three triangles with two sides of the Java chain, viz. G. Karang–Batoo Hideung and G. Karang–G. Gede; by means of four triangles the same side was now connected with the point G. Dempoo in the Lampong districts, which had been selected for astronomical station for the orientation of the Sumatra triangulation. In 1896 the building of pillars was commenced, and in the course of 1897 the angular measurements at the nine stations, besides the determination of the latitude and azimuth at G. Dempoo were completed. The mean error of the result of the determination of the latitude of G. Dempoo is 0″·21, and that of the result of the determination of the azimuth 0″·27. The latitude of the point G. Karang, as calculated from the Sumatra chain, differs 6″·5 from that derived from the Java chain, which difference may partly be ascribed to local declination. The azimuths at that point differ 5″·3, which is probably to a great extent due to the accumulation of errors in connection with the great distance of the point Genook in Japara, which served as starting-point for the computations of latitude and azimuth in the Java chain of triangles, and which is 540 km. from Karang. The publication of the determinations of latitude and azimuth carried out by the Geographical Service in West Java, will probably throw more light on the

cause of these differences.—Prof. Kamerlingh Onnes communicated on behalf of Mr. N. Kasterin, of Moscow, experiments on, and a theory of, the propagation of sound through a non-homogeneous medium. The solution given has been rendered general by means of spherical functions for a medium consisting of equal spheres in a state of rest and arranged parallelopipedically. Applications were made to the case when the dimensions of the spheres are small in comparison with the wave-length. Perfect analogy with the dispersion and absorption of light was found; the index of refraction, the dispersion curve, the absorption coefficient and the absorption bands in the acoustic spectrum were determined. The experiments were made with balls, arranged in tubes of quadratic cross section. Complete correspondence between observation and theory was found. The solution was also found for a medium, composed of gaseous spheres. Experiments, relative to this case, were made by placing a series of resonators in a Kundt's tube. Phase retardation on waves passing through impediments was previously observed by Kasterin in the case of capillary waves.—Prof. W. H. Julius presented a paper on a simple extension of the Gauss-Poggendorffian method of reflector reading, by which it becomes possible directly to read not only $tg\ 2\alpha$, but also $tg\ 4\alpha$, $tg\ 6\alpha$, $tg\ 8\alpha$, $tg\ \alpha$ . . . *ad lib.* This effect is produced by repeated reflections of the incident rays between the reflector and the slightly silvered back of a small glass plate, placed in front of it. A photograph of the field of vision in the telescope was added, in which the four images of the scale are seen simultaneously, the readings of which yield the various multiples of 2α.

DIARY OF SOCIETIES.

THURSDAY, MARCH 31.

ROYAL SOCIETY, at 4.30.—Total Eclipse of the Sun, January 1898: Preliminary Report on the Observations at Sahdol: W. H. M. Christie, C.B., F.R.S. (Astronomer Royal).—Preliminary Account of the Observations at Viziadrug: Sir J. Norman Lockyer, K.C.B., F.R.S.—Polariscopic Results at Sahdol: Prof. H. H. Turner, F.R.S.—Note on Photographs obtained at Ghoglee: Dr. R. Copeland (Astronomer Royal for Scotland).—Observations at Pulgaon: Captain E. H. Hills, R.E., and H. F. Newall.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Earthquake in Assam: Henry Luttman-Johnson.

ROYAL INSTITUTION, at 3.—Recent Researches in Magnetism and Diamagnetism: Prof. J. A. Fleming, F.R.S.

CHEMICAL SOCIETY, at 3.—Annual General Meeting.

CAMERA CLUB, at 8.15.—Prof. Joly's System of Colour Photography: Captain Abney, C.B., F.R.S.

FRIDAY, APRIL 1.

ROYAL INSTITUTION, at 9.—Liquid Air as an Analytic Agent: Prof. Dewar, F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—Addresses on the Excursion Programme for 1898: H. W. Monckton, Prof. J. F. Blake, and W. Whitaker, F.R.S.

MONDAY, APRIL 4.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Bacterial Treatment of Sewage containing Manufacturing Refuse: W. J. Dibdin.

VICTORIA INSTITUTE, at 4.30.—The Star-Worshippers in the East: S. M. Zwemer.

TUESDAY, APRIL 5.

SOCIETY OF ARTS, at 8.—The British Empire, its Resources and its Future: John Lowles.

ZOOLOGICAL SOCIETY, at 8.30.—On the Species of Corals of the Genus *Millepora*: Prof. Sydney J. Hickson, F.R.S.—On the Perforate Corals collected by the Author in the South Pacific: J. Stanley Gardiner.—On the Geographical Races of the Banting, *Bos sondaicus*: R. Lydekker, F.R.S.

MINERALOGICAL SOCIETY, at 8.—On Sphærostilbite: G. T. Prior.—On the Occurrence of Monasite and Niobates and Tantalates of the Rare Earths in Swaziland: G. T. Prior.—On Sennaite, a New Titanate of Iron, Lead, and Manganese from Brazil: Dr. E. Hussak and G. T. Prior.—On a Cubic Modification of Silver Iodide from Broken Hill, New South Wales: L. J. Spencer.—Crystallographic Notes on Laurionite and Phosgenite: Herbert Smith.—On Peculiar Quartz-Pseudomorphs found at the Owera Mine, Opitonui, North Island, New Zealand: Prof. G. H. F. Ulrich.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Extraordinary Floods in Southern India: their Causes and Destructive Effects on Railway Works: E. W. Stoney.—The Electricity Supply of London: A. H. Preece.

RÖNTGEN SOCIETY, at 8.—The Influence Machine and its advantages for Lighting X-Ray Tubes: James Wimshurst.

WEDNESDAY, APRIL 6.

GEOLOGICAL SOCIETY, at 8.—On some Palæolithic Implements from the Plateau-Gravels, and their evidence concerning Eolithic Man: W. Cunnington.—On the Grouping of some Divisions of Jurassic Time: S. S. Buckman.

ROYAL ASTRONOMICAL SOCIETY, at 8.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, APRIL 7.

MATHEMATICAL SOCIETY, at 8.—An Essay towards the Generating Functions of Temariants: Prof. Forsyth, F.R.S.—On Systems of Forces in Space of n Dimensions: W. H. Young.—Note on the Definition of a Continuum of n Dimensions: A. E. H. Love, F.R.S.—On the Zeroes of the Bessel Functions: H. M. Macdonald.

LINNEAN SOCIETY, at 8.—On the Brain of the Edentata, including Chlamydophorus: Dr. Elliott Smith.—Preliminary Account of some New Zealand Actiniaria: H. Farquhar.

BOOKS AND SERIALS RECEIVED.

BOOKS.—A Treatise on Magnetism and Electricity: Prof. A. Gray, Vol. 1 (Macmillan).—Comité Internationale des Poids et Mesures, Procès-Verbaux des Séances de 1897 (Paris, Gauthier-Villars).—Text-Book of Physiology: edited by Prof. E. A. Schäfer, Vol. 1 (Pentland).—Bergens Museums Aarbog, 1897 (Bergen).—Die Wettervorhersage: Prof. Dr. W. J. van Bebber, Zweite Auflage (Stuttgart, Enke).—Die Fundamentalen Physikalischen Eigenschaften der Krystale: Dr. W. Voigt (Leipzig, Veit).—Die Energetik: Dr. G. Helm (Leipzig Veit).—Statesman's Year-Book: edited by Dr. J. S. Keltie 1898 (Macmillan).—Hints on the Management of Hawks, &c.: J. E. Harting, 2nd edition (H. Cox).—What is Science?: Duke of Argyll (Edinburgh, Douglas).—The Mammals, Reptiles and Fishes of Essex: H. Laver (Chelmsford, Durrant).

SERIALS.—Memoirs of the Geological Survey of India, Vol. xxvii. Part 2 (Calcutta).—Ditto, Palæontologia Indica, ser. xv. Vol. 1, Part 4; Vol. 2, Part 1; ser. xvi. Vol 1, Parts 2 and 3 (Calcutta).—Astrophysical Journal, March (Chicago).—American Naturalist, February (Ginn).—Monthly Weather Review, December (Washington).—Journal of the Anthropological Institute, February (Paul).—Journal of the Chemical Society, March (Gurney).—Economic Journal, March (Macmillan).—Humanitarian, April (Hutchinson).—Longman's Magazine, April (Longmans).—Science Abstracts, February (Taylor).—Himmel und Erde, March (Berlin, Paetel).—Chambers's Journal, April (Chambers).

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THURSDAY, APRIL 7, 1898.

A MALPIGHI BICENTENARY VOLUME.

Marcello Malpighi e l'opera sua. Scritti varii. Pp. 338. (Milan: Vallardi, 1897.)

THE great Malpighi—Marcello Malpighi—to give him his full name, anatomist, physiologist, botanist, pathologist, biologist, and above all natural philosopher, striking and powerful man of science in the latter half of the seventeenth century, was born on March 10, 1628, in the house of his father, a farmer in easy circumstances in the outskirts of the town of Crevalore, which lies in the neighbourhood of Bologna.

Last year the town of Crevalore, with the help of others, erected in its market-place, opposite the town hall, a bronze statue of their great townsman as a tangible token of how much they felt his worth. Dr. Pizzoli, the Secretary of the Committee for the erection of the monument, conceived the happy idea of combining with the memorial of bronze one of another kind—one which should not be stationary at Crevalore, but wander far and wide—a printed book in which several men of science of different lands and pursuing different paths of inquiry might state what they knew and thought of their great common master of old times. Circumstances prevented the two memorials being completed in 1894, which would have been the bicentenary of Malpighi's death, this taking place on November 29, 1694; but the statue was unveiled last November, and the memorial volume is now before the world.

It would be out of place in a notice such as this to dwell at length on Malpighi's place in the history of biological science, or to attempt to discuss the value of his many and varied labours. I must content myself with giving a brief account of the contents of this memorial volume.

The several contributions are very varied, both in length and character; and as one reads them in succession, a great deal of repetition is met with; but this is unavoidable in a work written in the way in which this is written; and it may at least be said that all the contributions will reward perusal.

G. Atti (of Bologna) gives a biographical sketch, the shortness of which is, I cannot help thinking, much to be regretted; and though Prof. Atti has written at length elsewhere, I feel sure that a fuller relation of Malpighi's life, some genial narration of his personal story, free from any critical account of his scientific labours, would have been a very acceptable addition to the volume.

Virchow contributes an éloge, Haeckel an appreciative estimate of Malpighi as a philosophic naturalist, De Michelis (of Ravenna) an essay on Malpighi's place in the History of Thought, Todaro (of Rome) a sympathetic view of him as a pioneer in biological studies and as an advocate of experimental medicine being considered as an integral part of the study of living things, and De Giovanni (of Padua) an exposition of his place in the development of pathological science. All these are short, while the contribution of Weiss (of Messina), entitled a general introduction, dealing as it does with the several aspects of Malpighi's scientific activity, is necessarily longer.

Kölliker supplies a very brief but pregnant and admirable statement of the many notable discoveries in general anatomy which we owe to Malpighi, Romiti (of Pisa) an estimate, also short, of Malpighi's place in the history of topographical human anatomy, while Eternod (of Geneva) dwells more in detail on his worth as being one of the earliest to grasp the value of that research into minute structure, whether of plants or animals, which we now call Histology, and indeed as being one of the founders of a branch of biological science which has, especially in these latter days, gathered in so many and such important truths. Cattaneo (of Genoa) expounds at length and in detail the great man's many and varied contributions to comparative anatomy; and Perroncito (of Turin) adds a detailed account, which by reason of its very detail is most interesting, of Malpighi's famous work on the silk worm, "De Bombyce." It will be remembered that Malpighi was led to undertake this investigation in consequence of a letter which the Royal Society of London addressed to him, through the hand of its Secretary Oldenburgh, and that the volume containing the account of the investigation was published by and on the financial responsibility of the Royal Society, being the first of a series of works by Malpighi thus published. Indeed after this onward nearly all Malpighi's inquiries were published by the Royal Society.

We learn from Dr. Pizzoli's sympathetic preface that it had been intended to include a contribution on Malpighi as an embryologist, one of Malpighi's works being "De formatione pulli in ovo." Through misadventure this intention failed; but the value of Malpighi's work in this direction is touched upon by more than one of the contributors just mentioned.

Two contributions deal with Malpighi's botanical researches. At its meeting of December 7, 1671, there was read before the Royal Society a preliminary sketch by Malpighi of his botanical investigations under the title of "Anatomes Plantarum Idea"; and at the same meeting our countryman Nehemiah Grew laid before the Society a copy of his work entitled "The Anatomy of Plants begun," which the Society in the previous spring had ordered to be printed. Much controversy has arisen in respect to the relative merits of Malpighi and Grew as the founders of the anatomy of plants. One of the above two contributions is a short essay by Strasburger in which, while giving Grew all his due as an original inquirer, he claims for Malpighi a higher place as being a mind of wider grasp, as being one who in investigating plants was seeking a clue to the secrets not of plants only but of all living things. The other contribution, by Morini, is much longer and deals in detail with all Malpighi's botanical studies, incidentally touching also on the controversy about Grew, and giving a brief sketch of the condition of botany before Malpighi began his work.

I have myself contributed a condensed account of Malpighi's relations with the Royal Society, explaining in a simple manner how the correspondence between the one and the other began, how the Society undertook in succession the publication of Malpighi's most important works, and how cordial and close was the intercourse between the great Italian inquirer and the learned

English body. Some of the letters which passed between Malpighi and the Royal Society appear in the "Opera Omnia." But many others are preserved in the archives of the Society, and I thought that it would be well if all these saw the light. I accordingly have added these letters—some from Malpighi to the Society or to one or other of the Secretaries, others from the latter to Malpighi, in all forty-two in number—as an Appendix to what I have written. In doing this I received most valuable assistance from Mr. Herbert Rix, the late Assistant Secretary to the Society. Probably some printer's and other verbal errors have escaped the notice of both of us.

Lastly the volume contains an account, by L. Frati, of the various medals issued in honour of Malpighi, and a bibliography, by C. Frati, both of Malpighi's own writings and of various writings about him.

Dr. Pizzoli may certainly be congratulated on having produced an interesting and useful volume, the reading of which cannot but do good. To stand back from the present rush of inquiry and controversy, to look across two centuries at a great man, struggling with the beginnings of problems which have since come down to us, some in part solved, but others with their solutions put still further off by the very increase of knowledge, is a useful lesson to every one of us. In any case the great men who in the past opened up for us paths of inquiry—and among these Malpighi takes a foremost place—ought not to remain mere names, known to us chiefly through being attached to some structure or to some piece of apparatus. We ought all of us to be able to form some idea of what they were and what they thought. The present volume will be a great help to any one, who can read Italian, towards such an end in respect to Marcello Malpighi.

M. Foster.

THE ARYO-SEMITIC SCHOOL OF MYTHOLOGY.

Semitic Influence in Hellenic Mythology, with special reference to the recent mythological works of the Right Hon. Prof. F. Max Müller and Mr. Andrew Lang. By R. Brown, junior. Pp. xvi + 288. (London: Williams and Norgate, 1898.)

It has been a well-known fact for many years past that the breach between the linguistic and anthropological schools of mythology was growing steadily, and it was evident that a serious rupture must eventually occur. It was felt that the venerable linguistic method was being slowly but surely undermined by many workers, and that the anthropologists were consolidating their position in a remarkable manner. The rupture, however, might have been delayed, and the two schools might have made concessions mutually in the interests of the peace and progress of the science, the advancement of which each party professed to have at heart, had they been allowed to do so. But it was not to be, and the immediate cause of battle between the rival schools was the publication of Prof. Max Müller's "Contributions to the Science of Mythology," wherein the great writer discussed with his characteristic learning the subjects on which he is the first authority at present. This work was violently attacked by Mr. Andrew Lang, who, it cannot be denied, impressed many by his skill in word trickery and brilliant phrases, and the unwary reader may quite well be forgiven if he was led astray by a flood of journalistic eloquence. Those, however, who had any knowledge of the subject saw at once that Mr. Lang did not represent the anthropological school, and that he had no right to pretend to do so; for as is well known he has shown no evidence that he possesses any special knowledge of any one of the subjects which go to form that complex whole called mythology. Prof. Max Müller may have made mistakes, but he knows his languages; Mr. Lang has a competent knowledge of no Oriental language, and can never now acquire even a working hold upon the dialects of the East, wherein Prof. Max Müller was an authority thirty years ago. To us it seems doubtful if Mr. Lang has sufficient knowledge of Eastern linguistics to understand all the points of Prof. Max Müller's position. In any case Mr. Lang's attack upon the Oxford Professor was futile, and all it served to do was to show that Mr. Lang had mistaken his own powers, and that he had without any proper authority assumed to himself the right to act as spokesman for the anthropological school of mythology. Now, it seems, another combatant has joined in the fray in the person of Mr. Robert Brown, junior, who, though wishing to support Prof. Max Müller against Mr. Lang, has a few objections to urge against the venerable scholar, and an axe of his own to grind. Mr. Brown, like Mr. Lang, makes himself the spokesman of a "School," which, he says, "for present purposes, I may style the Aryo-Semitic," and though he recognises "the vast results that have sprung from the scientific application of Aryan linguistics," he is "in entire sympathy with the researches of anthropology in general, and of folk-lore in particular." The cynical outsider will have some difficulty in understanding the position of such a Mr. Facing-both-ways. As far as we can see, Mr. Brown has printed his book to prove that Hellenic mythology owes a pretty big debt to Semitic peoples; but then, no one, so far as we know, ever doubted this obvious fact. Mr. Brown has also taken a great dislike to Mr. Lang, the evidence of which forces itself upon the reader in several places. Mr. Brown's dislike is so strong that in order to relieve his feelings, he is obliged to write a number of childish things, which any friend of his would have excised from his manuscript before it was printed. Mr. Brown also falls foul of Mr. Frazer, the author of the "Golden Bough," and when, like Mr. Silas Wegg, Mr. Brown is obliged to "drop into poetry," and to print in a book intended to be serious the silly lines (p. 14),

> O Mr. Frazer, Mr. Frazer, what a man you are!
> I never thought when you set out that you would "go so far,"

we can only regret that Prof. Max Müller has been "taken up" by Mr. Brown. Moreover, to talk of a "Covent-garden-market theory of mythology" (p. 15) is hardly the language which we should expect from one who calls himself a supporter, and, in some respects, a disciple of Prof. Max Müller.

It is time to ask now what Mr. Brown's qualifications are for his self-assumed *rôle* of defender of Prof. Max Müller. In reading over his pages we see that a great many languages are quoted, and that a vigorous attempt has been made by Mr. Brown to mark the quantities of the vowels which occur in the extracts; the pages look not only learned but terrible. But it is one thing to be

able to find words in a dictionary, and another to know the language to which the dictionary is the key. Mr. Brown has written many papers on astronomical matters, and we are willing to assume, for the sake of argument, that they may be of value; but from the manner in which he writes the words of one of the languages which he quotes, that is to say Hebrew, we are convinced that his knowledge of it is of an elementary character. An example or two will show what we mean. On p. 115 he speaks of Sanchouniathan, meaning Sanchon-yathan (we leave out the vowel quantities because they are not necessary); this spelling shows that Mr. Brown took the name from a non-English book, and did not know that Sanchôn was the form of the god's name. The spelling Aschthârth (pp. 115 and 182) is another example of the same thing. On p. 116 (*bis*) he prints Qarnaîm for *Qarnayim*, which shows that he does not know how to transcribe the dual ending in Hebrew; the *a* cannot be long here unless it carries the accent. On p. 133 he gives *dayon* as the Hebrew for the word "judge"; as a matter of fact it is *dayyân;* on p. 149 he writes Ai lênu for *i lânu;* on p. 181, Qastu for *Qashtu;* on p. 182, Dagîm for *Dâgîm;* on p. 142, Kîyûn for *Kîyyûn;* on p. 133, anoshîm for *ănâshîm;* and so on in many places. These are not mere misprints, and they show the want of knowledge of elementary principles of Hebrew grammar. He often vocalises Phœnician words in defiance of all the laws which governed the Masoretes in their deliberations, and yet when he has good authority for adding the lengths of the vowels he fails to do so; see on p. 182, where he writes Kimah for *Kîmâh.* We cannot attempt to follow Mr. Brown in his Accadian, and "Hittite," and other little-known dialects, but the general impression which we gather from his book is that he is little more of a genuine expert in linguistic mythology than is Mr. Lang; and Mr. Lang is a brilliant, amusing writer, whilst Mr. Brown is not. The silly remarks on p. 85 are in very bad taste. The scholars of Oxford, Cambridge and London are only too glad to help on learning in any shape or form, and no honest worker is pushed aside at any of these places because he does not live there, or is not a graduate of the University. When professors of the Aryan and Semitic languages are convinced that Mr. Brown has a competent knowledge of these tongues, they will be prepared to believe that he knows accurately Accadian and "Hittite," and to accept his conclusions; meanwhile Mr. Brown's present work will delay that result.

DEVELOPMENTAL MECHANICS.

Programm und Forschungsmethoden der Entwicklungsmechanik der Organismen, leichverständlich dargestellt. Von Wilhelm Roux, o.ö. Professor der Anatomie und Direktor des anatomischen Instituts zu Halle. Zugleich eine Erwiderung auf O. Hertwig's Schrift Biologie und Mechanik. Pp. 203. (Leipzig: Verlag von Wilhelm Engelmann, 1897.)

It is questionable whether Dr. Wilhelm Roux does not do more harm than good to the cause which he has at heart by his excessive fondness for programmes. The work which lies before us is at least the fourth of a series of expositions of the nature, aims and methods of the subject of developmental mechanics, and it differs but little from its predecessors (consisting as it largely does of extracts and quotations from them, with explanatory and justificatory additions) in the complacent, not to say assertive, manner in which its author extols his own methods and aims at the expense of those which have hitherto been in use among zoologists. To our thinking Dr. Roux's weakness lies not in his aims, which are legitimate and praiseworthy, nor in his methods, which are carefully considered, but in the persistence with which he lectures his colleagues on their shortcomings and on his own rectitude. Different persons are differently affected by oft-repeated homilies: some will acquiesce, the greater number will escape by indifference, and others will be goaded into active hostility to what they regard as the pretensions of the author. To the last category belongs Dr. Oscar Hertwig, who has recently attacked Roux in an unsparing manner, asserting that his programme is obscure and wanting in novelty; that since it is not new the very name of developmental mechanics is superfluous and, moreover, incorrect; that the method, in so far as it is new, cannot lead to any progress in biology; that it is inapplicable to the subject; and finally, that in so far as it has been applied by Roux, it has been applied in so faulty and slovenly a manner as to have produced error instead of enlightenment.

The issue between the new method and the old is very clearly raised, and the present work is chiefly concerned in repelling Hertwig's attack. It would take far too much space to attempt to describe the numerous questions which enter into the dispute, questions which involve discussions on the laws of causation, on the theory of mechanics, on nomenclature, and on numerous matters of fact.

Our general impression after reading Roux's article, is that he has come out of the contest with credit, and that in some particulars he has successfully overthrown Hertwig's attack. It must be remembered that Roux is by no means an empty theorist: he has preached, as we think, over-much, but he has also practised largely and with great success, and whatever *à priori* objections may be taken to the methods which he inculcates, he has been able to show us, by the results which he has himself achieved, that the method of experiment may be applied with great advantage to the elucidation of embryological phenomena. His contention in this and earlier essays is, that the biological methods lately in vogue are purely descriptive and based upon simple observation, and that therefore they do not, and cannot, give a causal account of biological phenomena. To obtain a knowledge of causal relations, one must, says Roux, have recourse to experiment, and further than this, to "causal analytical experiment."

It is not quite easy to understand the antithesis between simple experiment and causal analytical experiment, though our author evidently attaches special value to the latter term, for he repeats it again and again. Seemingly it means nothing more than that every experiment should be conducted with strict attention to the particular question to be solved and with due regard to secondary and disturbing influences, conditions which, to the ordinary uninstructed person, would seem to be necessary to every experiment worthy of the name. This,

however, is a matter of secondary importance; Roux insists specially on the use of experiment—accurate painstaking experiment—in biological investigation. He further indicates that developing organisms afford the most fruitful field for the experimental method, for there one may most certainly hope to discover the formative forces which by their interaction co-operate to produce those formal changes which we have come to know by the method of simple observation. It is on this subject that Hertwig differs most widely with him. According to the latter author, there is no place for the experimental method in embryology. Experiment is nothing more than the production of changes of state in existences. In the inorganic world we have to deal with relatively stable existences, and before we can make any assertions of cause and effect about them we must bring about a change of state in them. In the organic world, however, the case is widely different. It is the characteristic of living bodies that they are always undergoing changes of state, and the changes are most characteristic and most conspicuous during the period of embryonic development. Thus nature does for man in the organic what he himself has to effect in the inorganic world, and it is only necessary for him to observe and record the natural successive changes in order to be able to state a series of relations of antecedent and consequent. Thus Hertwig says—

"Every antecedent state is the cause of that which follows it . . . a living frog's ovum is the antecedent which of invariable necessity leads to the establishment of a frog's gastrula as a consequent, if only the conditions and circumstances necessary to further development are fulfilled. For the words antecedent and consequent one may equally well substitute the words cause and effect. Hence embryological research, which 'describes' the change of the frog's ovum into the gastrula, asserts a causal relation, and in so far as it does this for all the stages of the development of the frog from the egg, it asserts the law of the development of the frog. In this sense the research of the last fifty years has brought to light the most important causal knowledge. Is not the recognition that the ovum and the spermatozoon are simple elementary organisms and that, as such, when the appropriate conditions are fulfilled, they unite in themselves all the causes (exception being made of *causæ externæ*) which are necessary to the production of a new being, and that they in fact bring it into existence, is not this a causal recognition?"

The above paragraph is quoted by Roux as illustrating very clearly the difference between his and Hertwig's standpoints. Hertwig imagines that the ends of science are fulfilled by the enumeration and description of different states, and holds that our task is finished when we are able to assert that any one state invariably proceeds from another state immediately preceding it. Roux admits the necessity and value of this knowledge, but declares that it is only a step towards a causal explanation of the phenomena, and is far from satisfying our desire for a full explanation.

An illustration will serve to make the point clear. Hertwig's position would be that of an astronomer who was content with the truth arrived at by Kepler, that the observed successive positions of the planets are due to their paths being elliptical. Having ascertained the nature of the planets' orbits, he would be justified in asserting that the observed positions of the planets were due to—that is, were caused by—the fact that their paths are elliptical. But this would not be a sufficient causal explanation of the planetary movements. There is clearly a further question as to why the paths are elliptical, and the elucidation of this question was reserved for Newton. Hertwig would suggest that embryological inquiry should stop short at a point analogous to that gained by Kepler, and that we should content ourselves with the assertion that the states which we observe in individual ontogenies are what they are because the organisms in question describe a sort of normal curve in the courses of their development. It is hardly possible to refuse one's sympathy to Roux when he declines to be content to stop at this point, and urges that the knowledge hitherto acquired is but a preliminary to further inquiry. Everybody who has studied and reflected upon the facts of embryology must have felt the necessity for further enlightenment as to why, and in virtue of what inherent energies the ovum is able to go through the complex succession of changes which lead to the establishment of the adult individual. Various theoretical solutions of the problem have been offered, but they have not proved satisfactory. Roux steps forward and shows that the only possible solution is by the method of experimental investigation. Since he himself admits that the problem was present to the mind of von Bär, it is clear that his aim is not new, and in this unimportant matter Hertwig is right; but if the aim is not new, it has only recently become practical, and Roux may lay claim to the chief credit of having seen that the time was ripe for trying to realise it.

But it is one thing to have a legitimate and definite object in view, another thing to devise the most appropriate means of attaining to it. Roux has entire faith in experiment. Hertwig objects to the experimental method, because in the act of making an experiment one disturbs the normal course of vital phenomena, and obtains abnormal results, from which nothing can with certainty be predicated as regards natural processes. Bütschli has in a similar sense objected that the introduction of disturbing factors into ontogeny involves a complication in the results, which can only be justly estimated when the elements of the mechanics of normal developmental processes are well ascertained. The answer to this is that no progress is possible if one allows one's self to be discouraged by *à priori* objections and difficulties, and that the method of experiment, so far as it has gone, has been successful almost beyond anticipation.

As regards the title "Developmental Mechanics" (*Entwicklungsmechanik*), which Roux justifies at some length, it need only be said here that the equivalent "Experimental Embryology" most generally used in England and America, though not expressly disavowed by him, differs in its connotation from the title which he has selected. Thus on p. 176, "Entwicklungsmechanik bedeutet also die Lehre von den Entwicklungsbewegungen": the essential idea is not contained in the term Experimental Embryology.

Roux's last task is to defend his practical methods and results against the criticisms of Hertwig, who has not hesitated to say that his preparations were so imperfect in point of histological technique that nothing could be

inferred from them. Roux retorts with a criticism of Hertwig's control experiments on the same objects (frog's ova), and it is difficult to decide between two observers who mutually accuse each other of inaccuracy and want of attention to detail.

So far as one can judge the advantage in the polemic lies with Roux, the more so because he invites our confidence by asking any one who is interested to come and inspect his preparations of hemiembryos, and to judge for himself whether or not he has described them truly, and whether they do not support the theoretical conclusions drawn from them.

BRITISH VERTEBRATES.

A Sketch of the Natural History (Vertebrates) of the British Isles. By F. G. Aflalo. 12mo, pp. xiv + 498. Illustrated. (Edinburgh and London: Blackwood and Sons, 1898.)

WITH the host of books in existence on British animals, it is a somewhat curious fact that, so far as we are aware, there is none which treats of all the vertebrates collectively, with the exception of Jenyns's "Manual," published in 1835. Still more curiously, that particular work happens to be omitted from the very useful bibliography Mr. Aflalo gives at the end of his little volume! Under these circumstances, the work before us fills a distinct gap; and as it is beautifully illustrated and brightly written, it ought to command a ready sale among those desirous of knowing something about the higher animals of our islands without being bored by technicalities.

Needless to say, it is not a book for the professed naturalist, and should not therefore be criticised from his standpoint. It has no pretence to be an advanced educational text-book; but is intended to appeal to those who have the "field-fever" strongly developed, and who are certainly in need of a cheap and portable volume dealing with all the vertebrates to be met with by field and flood in the British Isles. To be as accurate as possible without being dry, to produce a chatty little handbook, and not a dissecting-room manual, seems to have been the main object of the author; and in this laudable endeavour, in our opinion, he may fairly claim to have succeeded.

One very notable feature in the book is that scientific names are relegated to a series of tables, prefixed to the groups to which they refer, and that in the text the animals appear under the popular designations alone. This certainly renders the volume much more readable than would otherwise be the case. Special attention is given to the life-history of each animal treated; but descriptive details sufficient to distinguish the species from its British relatives are added, and in those cases where we have perused them, appear all that can be reasonably required.

Any nomenclatural list is now-a-days open to criticism, were we disposed to be critical on this subject. But in the main the author appears to have steered a fairly middle course between extreme innovations and old-fashioned views. In one case he is clearly wrong—namely, in calling the marten *Martes sylvatica*, and restricting *Mustela* to the polecats and weasels. In birds, we are glad to see he employs genera mostly in a wide sense, so that the blackbird and ouzels appear in the same genus as the song-thrush. But these are details in which his readers have probably little or no interest, and which his critic may therefore leave alone.

If we might suggest an improvement, it would have been to curtail the amount of space devoted to the sperm-whale, which scarcely comes under the designation of a British animal, and to give more details with regard to some of the smaller mammals. For instance, a little more might have been added as to the colour-changes of the squirrel, and the distinctive coloration of the tail of the British form; while further information as to the black variety of the water-vole being restricted to damp localities might have been desirable. Perhaps, however, the author is better acquainted with the tastes of his readers than is his critic; and personally we confess to much more interest in reading the anecdotes relating to ambergris than we should in wading through details of coloration of fur and feathers—important as these latter undoubtedly are in their proper place.

As regards paper, type, illustrations (from the facile pencil of Mr. Lodge), and freedom from misprints, the volume appears all that can be desired. As an Easter gift to friends, whether young or old, interested in the natural history of our own islands—which is the proper commencement of zoological studies—no volume could be more appropriate. R. L.

OUR BOOK SHELF.

Canada's Metals. By Prof. Roberts-Austen, C.B., D.C.L., F.R.S. Pp. 46. (London: Macmillan and Co., Ltd., 1898.)

THE address which Prof. Roberts-Austen delivered at the Toronto meeting of the British Association last year, and afterwards repeated at the Imperial Institute, was so well received on each occasion that there must be many who will welcome its appearance in book form. The main object of the address was to indicate the nature and distribution of Canada's mineral wealth; but, to lend additional interest to the subject, and afford a base for experimental illustration, a specific metal—nickel—which is especially Canada's own, was given the most prominent place in the discourse.

How great is the mineral wealth of the Dominion is understood by all who know the work and publications of the officers of the Canadian Geological Survey. Report upon report have been published on the mineral resources of the various provinces, but they have mostly gone unrecognised in England, and British efforts have been tardy in developing the riches in Canadian territory. Ten years ago Dr. Dawson published his exhaustive and glowing report on the mineral wealth of British Columbia, in which he pointed out the richness of the region in auriferous deposits, and stated that alluvial gold would probably be found in the bed of every tributary of the Yukon. Had British capitalists known how to value reports of this character, they would long ago have developed the Yukon basin instead of waiting until the success of placer mining at Forty Mile Creek in 1896 called public attention to the extraordinary richness of the district in precious metals. The facts brought together by Prof. Roberts-Austen will, however, help to make the extent and variety of Canada's mineral deposits better known than they have been, and will also show that, large as is the output at the present time, it will certainly be enormously exceeded in the future.

From the general subject of Canadian mineral resources, and the need for their development, Prof. Roberts-Austen passes to a particular metal—nickel. The splash of a falling marble which is dropped into milk, and of a gold bullet dropping into molten gold, is shown, by means of reproductions of photographs, to bear a resemblance to the splash produced upon armour plates by projectiles. To prevent the marble from entering the milk, the surface of the liquid might be hardened by freezing it. Using this illustration, Prof. Roberts-Austen ingeniously explains that in a similar way an armour plate should have a face of rigid steel to break up a projectile, and a tough back to save the plate from fracture. These conditions are obtained by the addition of 4 or 5 per cent. of nickel to steel.

There are many curious points connected with the relations of iron and nickel, and several of scientific interest are described in the present volume. Every one interested in the properties of metals, or desirous of obtaining a concise and trustworthy account of Canada's mineral riches, should read what Prof. Roberts-Austen has to say upon these subjects.

Hann, Hochstetter, Pokorny—Allgemeine Erdkunde, Fünfte, neu-bearbeitete Auflage. II. Abtheilung: Die feste Erdrinde und ihre Formen. Von Ed. Brückner. Pp. xii + 368. (Wien: F. Tempsky, 1898).

IN undertaking to produce a new edition of Hochstetter's share in the *Allgemeine Erdkunde*, Prof. Brückner very wisely determined to rewrite the whole section, and so to bring it into line with contemporary methods and results. The scope of this treatise on the crust of the earth and its forms includes a sketch of petrography, geological structure, stratigraphy, the agencies which work on the earth's surface (classed as endogenous and exogenous), the forms of the crust, and the morphology of the land-surface.

Prof. Brückner follows Richthofen and Penck for the most part; but his range is wide, and he pays due regard to the work of British and American geologists. It is particularly noteworthy that an authority who knows the Alps so well should refrain from making them the main source of his illustrative examples. In speaking of the interior of the earth the author leans to the view of the central part being in a gaseous state, the gaseous rock being reduced by intense pressure to a higher density than any liquid known on the surface; but he quotes and very impartially discusses the more generally accepted view of a solid earth due to the raised melting-point of rocks under pressure. Earthquakes are treated at some length; but the work of Milne is not referred to, Rebeur-Paschwitz being the principal modern authority cited. In discussing the origin of land-forms, more weight is given than in most text-books with which we are familiar to the importance of tilted or vertically displaced blocks of crust, and relatively less importance is attributed to folded structures. In treating of the *régime* of rivers and the classification of land-forms, Prof. Brückner follows Penck closely.

A number of useful references are given to special works treating on the special departments under notice; and it is gratifying to find a fair proportion of English books amongst those cited. In speaking of caverns, however, the author fails to mention M. Martel's important researches, or to refer to the Speleological Society. The revision of the work is very thorough; the only serious misprint of proper names we have noticed is the citation of the author of the *Mundus Subterraneus* as "Kirchner" in place of "Kircher."

This important work, so well-written by a master of his subject, is simply one amongst many German books on physical geography, a class still very poorly represented in the English language. H. R. M.

Elementary Botany. By Percy Groom, M.A., F.L.S. Pp. x + 252. (London: G. Bell and Sons, 1898.)

IN his preface the author explains that his object has been "to place the subject before elementary students in such a way as to exercise to the full their powers of observation, and to enable them to make accurate deductions for themselves from the facts which they observe." The book is written on the assumption that a compound microscope is not employed; and in the section on physiology no knowledge of the histology of plants is assumed. There are already numerous books more or less suitable as guides to the student of elementary botany, some of them so excellent as to leave little, if anything, to be desired in their special fields. But they either omit a good deal that might readily enough be examined and verified even by beginners, or they require such a use of the compound microscope as is scarcely practicable in the teaching of botany in schools. A book on the lines indicated by Mr. Groom should prove very helpful alike to beginners and to teachers, and would doubtless be welcomed if felt to be the result of adequate personal experience. But we cannot altogether congratulate the author on his success in carrying out his objects, despite the merits of his work, especially if it is intended as a school-book. Children can scarcely be expected to benefit as much from the study of general morphology as from the examination of selected plants, in which they could observe and gradually become familiar with the various structures and life-histories.

The definitions of terms are at times scarcely in keeping with general usage; for example, those of *compound leaves*, *æstivation* and *vernation*, and *compound fruits*. It may be questioned whether the statement—"that portion of a single flower which persists after fertilisation until the seeds are ripe is termed the fruit"—is preferable to the usual definition. The classification of fruits also is unsatisfactory.

Such a statement as that "a root can only produce as lateral members branches like itself" is misleading, and indicates want of care. The production of buds by roots can easily be verified; indeed, the author refers to their growth on roots under "adventitious shoots."

In the physiology a knowledge of chemistry is assumed to an extent beyond what is to be looked for in many schools. In consequence a good deal of this section could be little more than words to those for whom the book seems to be intended. The plants treated of all belong to the flowering plants, though there seems no good reason why representatives of the larger cryptogams should not find a place in such a work. But the task of a censor is unpleasant; and although it has been necessary to criticise what must impair the usefulness of the book, we gladly recognise that it should often be found suggestive by teachers and others possessed of sufficient knowledge to avoid being misled where the risk exists. The book is well printed, and is of very convenient size, and the illustrations are good and numerous; but it would have made them more useful had some of them been repeated where more than once particularly referred to and explained. References to figures, sometimes many pages back, are apt to be irritating.

Alembic Club Reprints. No. 13. *The Early History of Chlorine.* No. 14. *Researches on Molecular Asymmetry.* Pp. 46 and 48. (Edinburgh: W. F. Clay, 1897.)

THE first of these reprints contains translations of papers by Carl Wilhelm Scheele (1774), C. L. Berthollet (1785), Guyton de Morveau (1787), and J. L. Gay-Lussac and L. J. Thenard (1809). This volume, together with the earlier reprint in this series (No. 9), containing Davy's researches, completes the history of chlorine from its discovery by Scheele to the proof of its elementary nature by Davy. The importance of this discussion upon the

development of chemistry is obvious, but it is somewhat difficult to step back from what is now common-place knowledge, to the standpoint of these early pioneers. The paper of Scheele, although worded in terms of the theory of phlogiston, is remarkable for its terseness and lucidity, and for the clear and correct ideas expressed upon the nature of the new gas. Indeed, if the word hydrogen be substituted for phlogiston, Scheele's explanation of the action of hydrochloric acid upon the black oxide of manganese almost represents our present knowledge. Berthollet, on the other hand, writes very voluminously upon a very slender experimental basis, and as an ardent exponent of the views of Lavoisier, concludes that chlorine gas is the oxide of an unknown radical, and this fixed idea leads to quite erroneous interpretations of observed facts.

That the effect of a preconceived idea, however, is not always prejudicial, is shown in the two lectures by Pasteur on Molecular Asymmetry, which form the contents of the second of the reprints under notice. Here Pasteur distinctly states that but for his preconceived idea as to the inter-relation of hemihedry and rotatory phenomena, he would not have discovered the opposite hemihedry of the paratartrate and tartrate of soda and ammonia; a difference missed by so careful an observer as Mitscherlich.

The English translation of these famous lectures possesses all the charm of the original. In them we have a complete account of Pasteur's work on optically active compounds, and, as the editor states in the preface, it is remarkable that the three ways of separating optical isomers here described are still the only ones known, and that there is scarcely a statement which would be changed if the whole were to be written to-day.

Practical Toxicology for Physicians and Students. By Prof. Dr. Rudolf Kobert, late Director of the Pharmacological Institute, Dorpat, Russia. Translated and edited by L. H. Friedburg, Ph.D. Pp. xiii + 201. (New York: William R. Jenkins, 1897.)

THE work before us is a translation of a book by Prof. Kobert, the second edition of which was issued in 1887. While the author was engaged upon his "Lehrbuch der Intoxicationen," by which he is for the most part known in this country, and with which the present work must not be confused, he allowed the latter to run out of print. In 1894 he wrote the third German edition, and it is this which Dr. Friedburg has now translated and edited, three years after its issue. As we have not had the opportunity of seeing the third German edition of the original, we are unable to measure either the quality or extent of Dr. Friedburg's editing. With regard to his translating, it is the worst which has ever come under our notice. In fact the English language, in Dr. Friedburg's hands, is extremely difficult to understand. As this is a very strong statement it behoves us to give an instance, which, by the way, is not the worst we could find. Dr. Friedburg is speaking of a rise of blood pressure of peripheral origin. "If this is the case, the rise must obtain after the injection of the poison into the blood of an animal even if the marrow of the neck has been cut through and whose spinal marrow has been drilled out." We quote this instance, since it shows that the author is not only deplorably ignorant of the English language, but has no knowledge of the English equivalents of German physiological expressions. Dr. Friedburg's Latin is no better than his English; the plural of vagus is always written "vagii," and so polymorphic is the declension of this noun that we find the nominative singular written "vagis."

To turn from the manner of the book to the matter, it is undoubtedly full of information, and, if properly translated by some one acquainted with pharmacological method and the English language, would be valuable to both the pharmacologist and toxicologist. F. W. T.

What is Life? or, Where are we? What are we? Whence did we come? and Whither do we go? By Frederick Hovenden, F.L.S., F.G.S., F.R.M.S Pp. xiv + 290. (London: Chapman and Hall, 1897.)

MANY matters are dealt with in this book, ranging from the stellar universe to cell structure. About half the text is made up of quotations from the writings and utterances of men of science, distinguished and otherwise, and the remainder consists of perplexing conclusions which the extracts are held to support. Excessive zeal is shown in establishing fundamental truths, but that may be forgiven. It is when the author expands into the ether, so as to embrace in his comprehensive idea such diverse subjects as the Pentateuch and the currency question, that we lose the connections of the argument. The chief conclusions arrived at are stated in the following words:—

"From the combining power of the strongest species of atoms under the influence of Ether, arises the formation of cells.

"Cells under the influence of the strongest cell group themselves to form highly complex structures or organisms, hence the most complex of all organisms—Man. The activity of cells forms that activity we call Human Life. Thus Life is the sum of the activity or energy of molecules formed of atoms.

"The power of the regeneration of molecules causes regeneration of cells, and this causes regeneration of Life. Life is eternal."

La Tuberculose et son Traitement hygiénique. Par Prosper Merklen, Interne des hôpitaux de Paris. Edited by Felix Alcan. Pp. 190. (Paris: Ancienne Librairie Germer, Baillière et Cie.)

THIS little book forms No. cxix. of the "Bibliothèque Utile" series, and is certainly calculated to serve a useful purpose. It addresses the public, and not the medical profession. The nature of tubercular disease is very clearly and accurately set forth in plain language, together with its chief manifestations in man, and the principles underlying its prophylaxis and treatment. It is indisputably true that in the case of a preventable disease like tuberculosis, which constitutes one of the main scourges of civilised man, a dissemination of sound knowledge on the subject is the first necessary step in educating public opinion up to the hygienic requirements and sanitary restrictions which are demanded to check its spread. The present brochure is a creditable effort in this direction: the author has succeeded in placing home truths on the subject in a very clear light, and his remarks cannot fail to be of direct benefit to the public.

Marriage Customs in Many Lands. By the Rev. H. N. Hutchinson, B.A., F.G.S. Pp. xii + 348. (London: Seeley and Co., Ltd., 1897.)

MR. HUTCHINSON, forsaking geological subjects for a time, presents in this volume a purely popular account of the quaint customs connected with marriage in many parts of the world. He has not attempted to discuss the scientific questions relating to the history and origin of human marriage, but has merely aimed at providing the general public with readable descriptions of curious nuptial ceremonies of various peoples and races. The readers for whom the volume is intended will find much to interest and amuse them in it; and the excellent illustrations—among the best of their kind—give the book additional attraction. Authorities may not agree with all Mr. Hutchinson says; but, as the book is a compilation, the mistakes are usually the mistakes of the sources from which the information has been derived, and the only criticism that can be offered is whether the author has exercised sufficient discrimination in the collection of material.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Misleading Applications of Familiar Scientific Terms.

May I, not as an expert in science, but as one who has made some research into the conditions of lucidity, venture to thank you for the protest which appears in your current number against a misleading application of the familiar term "Light"? This is not of course the only instance of the kind; but it seems especially regrettable as tending, by the very success and popularity of the Lectures reviewed, to introduce gratuitous confusion into youthful minds.

I may perhaps be pardoned for adding that I was fortunate enough in my little book, "Grains of Sense," published last year, to anticipate the verdict of your reviewer, and to point out how much, in this and similar cases, such modes of expression on the part of scientific men tend on the one hand to diminish our precious and too slender store of clearness of thought, and on the other to hinder the progress of science itself.

V. Welby.

April 1.

The Kinetic Theory and Radiant Energy.

In the course of the discussion which took place in your columns during the winter of 1894-5 on the kinetic theory of gases, emphasis was rightly laid on the difficulty of reconciling the law of partition of energy among the different degrees of freedom of molecules of gases with the large number of such degrees of freedom indicated by their spectra, and, generally, of explaining, on the kinetic theory, the relations between matter and the ether required to account for radiation. It was even suggested, by one writer, that the ether, with its vastly larger number of degrees of freedom, must ultimately absorb all the energy of the molecules. I instanced the case of a sphere moving in an infinite mass of perfect liquid as exemplifying a system where no such ultimate absorption of energy would take place, and pointed out that everything depended on the laws according to which transference of energy took place between the molecules and the ether.

The object of this letter is to show that the subsequent discovery of the Röntgen rays has suggested a theory of the radiation of heat which may possibly throw considerable light on the difficulties referred to by affording an answer to the question, "If the temperature of a gas is proportional to the mean translational kinetic energy of the molecules, how comes it that this kinetic energy can be transferred from one set of molecules to another by radiation through the ether?"

Consider the Röntgen rays: we know, firstly, that they are produced by the impact of the kathodic rays on the Crookes' tube, these latter consisting not improbably of streams of bombarding molecules; secondly, that they not only have the power of discharging electrified bodies, but also of modifying the electrical state of gases in such a way as to enable these to discharge bodies. In this modified air, to which Villari has applied the somewhat barbarous name of "aria Xata" or "xd. air," some kind of dissociation of the electrons must necessarily have taken place.

Arguing from analogy the idea suggests itself that the encounters between molecules of a gas, no less than the kathodic bombardments, may give rise to radiations, and these, too, when falling on another mass of gas may modify the electrical state of its molecules in such a way that their original electrical state is only restored by encounters between them.

Now taking, as a simple illustration, two oppositely electrified perfectly elastic conducting spheres; as these approach one another, they acquire kinetic energy in virtue of their attraction. On coming into contact they are discharged and the attraction ceases, so that their kinetic energy of separation is greater than that which they had previously to coming within each other's influence. Again, when a charged and an uncharged body impinge, the charge is distributed between them; they repel one another as they separate, and again acquire an increase of kinetic energy—as in the ordinargy pith-ball experiment.

It follows that the incidence of rays possessing the property suggested above will tend to increase the temperature of a gas.

The discharge which takes place at an encounter will, however, be an oscillatory one, and will lead, therefore, to further generation of undulatory rays.

Considering two masses of gas at unequal temperature, the impacts in the hotter gas, being the more frequent and violent, will give rise to the more copious emission of rays, and these falling on the cooler gas, will produce the greater electric dissociation resulting in the greater acquisition of kinetic energy in collisions between the molecules. The feebler rays from the colder gas will have less effect on the molecules of the hotter one, and the kinetic energy supplied in this way will not compensate for that lost by radiation. Thus the "theory of exchanges" will hold good.

A still more important consequence of such a theory is that no interaction will take place between the ether and molecules except where there are encounters between the latter, and, moreover, the interactions which occur in an isolated mass of gas will not affect the translational velocity of its centre of mass, nor the angular momenta about axes through its centre of mass. Thus it results that the celestial bodies go on in their course experiencing no resistance whatever from the ether.

On the other hand, the fact that light from distant stars is not absorbed before it reaches the earth, no longer implies the complete absence of matter in interstellar space. Isolated molecules will absorb no energy from the ether; and so long as the molecules moving about in interstellar space are assumed to be so few and far between that collisions practically never occur, there will be nothing to impede the passage of light or heat rays. It is only when such rays fall on assemblages of molecules sufficiently dense to possess the attributes of what we call *matter*—as, for example, when they reach our atmosphere—that absorption of energy will take place.

The phenomena of irreversibility and of degradation of energy would thus, so far as the present view goes, be restricted to material bodies, and hence the conditions necessary for the existence of life on our earth may have been brought about without the enormous waste of energy which would be required in the absence of *some* such theory.

A photo-voltaic theory of photographic action formed the subject of exhaustive experimental investigation at the hands of Herr Luggin last year, and photo-voltaic theories of vision have also been proposed. It would thus seem that the analogy between the action of heat rays, visible-light rays, ultra-violet rays and Röntgen rays may be complete. The question still remains, *how* are ethereal waves able to affect the electric state of assemblages of molecules? But since Röntgen-ray physicists have proved that they do this, the question has to be faced in any case. It is now rendered no more difficult, and, on the other hand, our theories of the relations between ether and matter are simplified by referring radiation of heat to the same phenomenon.

G. H. Bryan.

Note on Mr. Wood's Method of Illustrating Planetary Orbits.

I fear that Mr. Wood's beautiful method of illustrating planetary orbits by means of a bicycle ball rolling on a glass plate about the pole of an electro-magnet (Nature, April 29, 1897), has rather fallen into disrepute in the minds of many physicists since its criticism by Mr. Anderson in Nature, May 13, 1897. Mr. Anderson there states that the law of attraction in such a case would be that of the inverse fifth power of the distance. This could only be true if the ball were of very soft iron. A bicycle ball is far from this, and becomes strongly magnetised after brief use in the experiment, behaving like a permanent magnet of great coercive force. Under these conditions the attraction between the pole and the ball will vary approximately as the inverse third power. There is also another factor to be considered. If the true pole lies below the glass plate, only a certain component of the total force is active in producing the attraction towards the centre of motion. To determine what the law of variation of this component will be, I have had one of my students take a number of series of observations on the attraction of a bicycle ball along a plane perpendicular to the axis of a magnet.

In the experiments the magnet was horizontal, and the bicycle ball with its magnetic axis vertical was fastened to one end of a strip of spring brass, the other end of which was clamped fast in

a sliding clamp so as to be raised and lowered. The bending of the brass strip under the attraction of the magnet on the ball was measured by means of a telescope and scale, the mirror being fastened to the end of the strip. As the motion of the ball was entirely in a plane perpendicular to the axis of the magnet, the law of variation of force must have been very nearly the same as in the orbit experiments.

When the ball was directly over the true pole, which lay about 1 cm. from the end of the conical pole-piece, the law was nearly that of the inverse cube, the observations being taken between the limits of 3 cm. and 14 cm. from the axis of the magnet. Other series were taken with the plane of motion of the ball at different distances from the pole, and it was found that with the plane of motion at 2·8 cm. from the true pole the law of the inverse square was very closely obeyed between 4 cm. and 14 cm. from the axis. These limits cover the region in which the orbits would in most cases be formed. The exact law of force as determined by least squares from seven observations between the above limits was that of the 2·1 power of the distance.

LOUIS W. AUSTIN.

The University of Wisconsin, Madison, Wis., March 16.

An Extraordinary Heron's Nest.

I SEND you a photograph of probably the most extraordinary heron's nest ever discovered in this or any other country. During a gale it was blown from the top of an elm tree in the heronry on Stoke Hall estate in Notts, the seat of Sir Henry Bromley, Bart. It is of unusual size, and almost exclusively composed of wire of varying lengths and thickness; the centre, or "cup," alone being composed of fine twigs, grasses and feathers. Several other nests of the heronry, which had also been blown down, contained pieces of wire cleverly worked in with twigs in the usual way, but this was the only one entirely composed of that material, as far as the main structure is concerned. There are happily now a very flourishing heronry at Dallam Tower, Westmorland, the seat of Sir Henry Bromley's son, Mr. Maurice

Bromley-Wilson, and although I have been familiar with it "off and on" for very many years, and with several other heronries in various parts of the country, I never knew of the birds using wire in the construction of their nests. I have several records of rooks using wire in large quantities in the construction of their nests. Particulars of one very remarkable instance were published in the *Yorkshire Weekly Post* of May 19, 1894, and of another in the same paper for June 23, 1894. Both of these freaks took place in India: one at Calcutta, the other at Rangoon. The other curious feature of the Stoke Hall phenomenon is that there is, and never has been, any lack of ordinary building material, and that all the wire used must have been carried a great distance.

G. W. MURDOCH.

Westmorland.

"The Story of Gloucester."

REFERRING to your article (p. 221), I think you cannot have looked at pages 70 to 117 of the Gloucester Small-pox Epidemic Blue Book, by Dr. Coupland. I have analysed all these cases, and here is the result.

Description.	Cases.	Deaths.	Deaths per cent. of cases.
"*Unvaccinated*"— These contain 21 cases, 10 deaths, whose description includes the word vaccination or vaccinated	679	287	42·2
"Vaccinated in infancy," no description of vacc. marks ...	788	91	11·5
Do. "no marks," very abundant small-pox eruption	35	13	37·1
Do. "one" vacc. mark	30	3	10·0
Do. two do.	100	10	10·0
Do. three do.	141	13	9·2
Do *4, 5, 6, 7 and 8 vacc. marks*	197	13	6·5
Do. (?) v. marks, very abundant eruption	9	4	44·4
Totals	1979	434	21·9

The accepted fatality before Jenner's birth was ... 16 6

There were—	Cases.	Deaths.	
Re-vaccinated cases at Gloucester	173	9	5·2

These had all kinds of v. marks *up to 8 in number*, and some had been *repeatedly* re-vaccinated; one "often" re-vaccinated. If the same energy had been put into a critical proof of the vaccination of each one as was into avoiding condemning vaccination, there would be little to show, even in fatality, in the above *for* vaccination; as it is, it kills *every* vaccine dogma.

ALEX. WHEELER.

MR. WHEELER, it must be assumed, is wishful to prove that the fatality amongst the vaccinated is as high, or at any rate is not lower than amongst the non-vaccinated. It is surely not necessary for him to separate vaccinated cases into those "with marks" and those with "no marks," since to him it should be immaterial whether a patient be vaccinated or not.

Taking Mr. Wheeler's own classification, we find that of the unvaccinated cases, 679 in number, 287 died, giving a percentage mortality of 42·2; whilst of the vaccinated cases, 1300 in number, only 147, or 11·3 per cent., died. These figures should surely be enough to settle the question as regards percentage mortality, and the mere inclusion of the 21 cases and 10 deaths, whose description includes the word "vaccination" or "vaccinated," does not in any way invalidate the general conclusions to be drawn from these figures.

If now, however, a class for the "under-vaccinated" be included, the second class may be divided into "under-vaccinated" 89 cases with 27 deaths, or 30·3 per cent., and vaccinated 1211 with 120 deaths, giving a mortality of only 9·9 per cent. It is evident that Mr. Wheeler's table in no way conflicts with the figures given in the Report (except in one small particular, noted below), but is based on a misconception of the term "under-vaccination" as used by Dr. Coupland, who used the term to signify those cases of small-pox which had undergone vaccination at any time within the (generally accepted) period of incubation: *i.e.* fourteen days before the appearance of the rash. In the list of "unvaccinated" cases are included a few which were actually vaccinated in the invasion period. No doubt some of these should be placed in the vaccinated class; but others, again, should be grouped in the unvaccinated class. The Royal Commission reckoned the whole group, instead of a large proportion, in this latter class, which is perhaps not strictly scientific and accurate. Mr. Wheeler, however, goes far further astray in including them all in the vaccinated class, which is clearly erroneous. It may be pointed out in this connection that, in his recently published work, Dr. Cory gives some most interesting facts which tend to show that vaccinal immunity is not obtained until nine days have elapsed after inoculation. It would be easy, therefore, from the table on page 149 of the Report, to divide the total 89, there reckoned as "under vaccination," into two sections: (*a*) those vaccinated before, and (*b*) those vaccinated within eight days, of manifesting small-pox. If this were done, there would be added (*a*) to the

"vaccinated" class 10 cases with 3 deaths; and (b) to the "unvaccinated" class 79 cases with 24 deaths.

Without checking Mr. Wheeler's figures by laboriously going through pages 70–117 of the Report, it is simply necessary to deduct those "under-vaccinated" from his several lists. His classes of "no marks" and "? marks" correspond with Dr. Coupland's groups of "alleged" and "doubtful" vaccination, except that Dr. Coupland's figures give one case less and one death more than Mr. Wheeler's. Although it is highly probable that many of these uncertain and doubtful cases were really unvaccinated, the Report includes them, as does Mr. Wheeler, in the "vaccinated" class (see page 153, &c.).

unvaccinated 255; this, too, in families of the same class, in the same streets, and living under similar sanitary (or unsanitary) surroundings as those in which every child was unvaccinated. May we not legitimately infer that had all the Gloucester children at these ages been vaccinated, only 1/7th of those that did suffer would have suffered, and the mortality would have been less than 1/60th of that to which it did attain? Vaccinators are said to be incapable of viewing this subject impartially, but Dr. Coupland is most judicious in the handling of his figures, and it is apparent that the evidence that he has collected from careful observation weighs with him as much or more than do the figures he has brought together; and it is certain

Mr. Wheeler's Figures distributed on Plan of Report.

Mr. Wheeler's table.				Vaccinated.		"Alleged" vaccination (no marks).		Doubtful vaccination.		"Under" vaccination.		Unvaccinated.		—	
—	Cases.	Deaths.	—	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
"Unvaccinated"	679	287	42·2	—	—	—	—	—	—	—	—	679	287	679	287
"Vaccinated in infancy," no description of v. marks	788	91	11·5	730	70	—	—	—	—	59	20	—	—	789*	90*
Do. "no marks," very abundant small-pox eruption	35	13	37·1	—	—	35	13	—	—	—	—	—	—	35	13
Do. "one" v. mark ...	30	3	10·0	29	3	—	—	—	—	1	—	—	—	30	3
Do. "two" do.	100	10	10·0	92	8	—	—	—	—	8	2	—	—	100	10
Do. "three" do. ..	141	13	9·2	130	9	—	—	—	—	11	4	—	—	141	13
Do. 4, 5, 6, 7 & 8 do.	197	13	6·5	187	12	—	—	—	—	10	1	—	—	197	13
Do. "?" v. marks, very abundant eruption ...	9	4	44·4	—	—	5	3	3	2	—	—	—	—	8*	5*
	1979	434	21·9	1168	102	40	16	3	2	89	27	679	287	1979	434
		Fatality ...		...	8·7	—	40·0	—	66·6	—	30·3	—	42·2	—	21·9

* Discrepancy due to inclusion by Mr. Wheeler of one death too many among "vaccinated in infancy," and one case too many among the "? vaccinated."

It is difficult to grasp Mr. Wheeler's point in presenting the figures in this way. It might be useful if these questionable cases had all been turned over to the "unvaccinated" class; but why does he detach them from the rest of the admittedly vaccinated? He could not have intended to show, as his own figures do, that post-vaccinal fatality diminishes with a rise in the presumed greater efficiency of vaccination as evidenced by the number of scars. Dr. Coupland does not enter into the question of marks. It has been done over and over again, and in both his Dewsbury and Leicester Reports Dr. Coupland makes a most valuable contribution to this question. The main object of the inquiry at Gloucester was to determine the broad question of the occurrence and fatality of small-pox in the vaccinated and unvaccinated.

Perhaps the most important point that the Gloucester epidemic illustrated is one that is passed over by Mr. Wheeler, and one which unfortunately appears as though the opponents of vaccination in their pursuit of a fad had become callous to the fate, in this instance, of the Gloucester children, but also of the children wherever there is an outbreak of small-pox.

About the effects of the vaccination or non-vaccination of children there can be no dispute. In this connection it is only necessary to refer to the figures of those attacked between one and ten years of age, and especially at the incidence rates given near the end of the Report. Indeed, if only those households are taken in which some vaccinated children are to be found, it appears that the incidence of small-pox *among the vaccinated children* was only 10 to 100, though amongst their unvaccinated brothers and sisters it was 10 to 14; whilst the death rate (per 1000 of those exposed to infection) was for the vaccinated less than 4, for the

that if those who deny the efficacy of vaccination could have the experience that he has had, they would cease to hold the view that he is prejudiced. Any one who considers his Report judicially must confess that he has presented the facts extremely fairly and impartially, and that he evinces far less bias than those who, on very slight and shadowy information, are undoubtedly unreasonably opposed to vaccination—the very people, in most cases, who bring the charge of partiality. Every one knows that where large numbers of statistics have to be collected, errors of fact may creep into records, and that, with fuller knowledge, slight modifications may have from time to time to be made. As regards the main facts of Dr. Coupland's records, however, the most exacting will find it difficult to trace any important inaccuracy. In respect to the records concerning children the facts are indisputable, and lead to the mournful conclusion that amongst these there would have been vastly less suffering and far fewer deaths in the Gloucester epidemic, had not infant vaccination been so widely neglected.

As regards re-vaccination it is difficult to see how Mr. Wheeler obtains the figure 173. In the table (p. 46) there are given 190 who were stated to have been re-vaccinated. Assuming that each of these was really and efficiently re-vaccinated—a large assumption—the fatality would be 4·7, or much below the general vaccination rate. There are, however, several difficulties to be surmounted before a satisfactory demonstration of the relationship of re-vaccination to small-pox can be arrived at; and one of these especially, that of the true interpretation of a failure "to take," is a most important one. This failure "to take" does not necessarily imply that the subject is immune. Then there is also the fallacy of recent re-vaccination which, like recent primary vaccination, may have been done too close to the date of the

onset of small-pox to have any influence on the disease (see following table) :—

Small-pox in the "Re-vaccinated."

190 persons who were *stated to have been* re-vaccinated were attacked by small-pox. Of these :

(*a*) 52 were "re-vaccinated" at various periods prior to epidemic, in some cases several years.

In 37 this re-vaccination was stated to have been successful, and 2 of these patients died.

In 15 this re-vaccination did "*not take*"—1 died.

(*b*) 30 were "re-vaccinated" between 3 months and 14 days of the attack of small-pox.

In 8 the vaccination "took."
In 22 ,, ,, "*did not take.*"

(*c*) 108 were "re-vaccinated" within 14 days of appearance of small-pox eruption, some of them even in early days of attack.

In 83 vaccine vesicles appeared—4 died.
In 25 the vaccination *did* "*not take*"—1 died.

Where Re-vaccination believed to have been successful.

(*a*) 37 cases—2 deaths—fatality 5·4 per cent.
(*b*) 8 ,, 0 ,, ,, *nil.*
(*c*) 83 ,, 4 ,, ,, 4·8 per cent.

Where Re-vaccination known to have been unsuccessful.

(*a*) 15 cases—2 deaths—fatality 13·3 per cent.
(*b*) 22 ,, 0 ,, ,, *nil.*
(*c*) 25 ,, 1 ,, ,, 4·0 per cent.

Or of whole number, 4·8 per cent. ; or if we take whole number (190), irrespective of date or of success, a fatality of 4·7 per cent.

Mr. Wheeler's statement that the accepted fatality before Jenner's birth was 16·6 has very little bearing on the question, since the epidemic at Gloucester gave 21·9, and this, including the 42·2 per cent. unvaccinated fatality at all ages, which is less than that between 1 and 10 years, the period of most fatal small-pox, in the pre-vaccination days. The Gloucester outbreak was undoubtedly unusually virulent ; but, surely, equally severe epidemics are on record.

THE WRITER OF THE ARTICLE.

THE SOUTH KENSINGTON SCIENCE BUILDINGS.

WE are glad to see that the various important matters connected with the extraordinary proposal to spend some eight hundred thousand pounds in interlacing the Science with the Art buildings—chemical laboratories with picture galleries—are being considered by a Parliamentary Committee. This is more especially desirable, since, as we have previously pointed out, it is stated that about half the money proposed to be spent is sufficient for present needs.

The *Times* gives the following account of the meeting of the Select Committee on Friday last, Sir F. S. Powell presiding. Sir John Donnelly, secretary to the department, was further examined. Sir H. Howorth said it would be of great assistance to the Committee if they could get from the officials of the department an expression of their views as to the changes which were desirable or were not desirable in regard to the housing of the Science and Art collections. The witness said that was rather an awkward question ; he really did not think it would be proper for him to volunteer any statement which might conflict with the present proposals of the Treasury and the Board of Works. He had already stated that, in his opinion, the Science collections should be on the west side of Exhibition Road and the Art collections on the east side. He believed that that was the proper solution of the South Kensington question, and he had seen no reason in what had taken place since he gave expression to that view to change his opinion. Sir H. Howorth: Mr. Akers Douglas has stated that, with the removal of the residences and of the secretarial offices to Whitehall, the Government find that they will have at their disposal a much larger space than had been previously contemplated, and that therefore they will be able to put the Science and Art collections on the one side of Exhibition Road. Do you think the space thus provided will be sufficient for the whole of the collections being placed together? The witness: I do not think so, and that was my reason for saying that I saw no ground for changing the opinion I have already expressed on the subject. I contemplate that the museums will increase, and I do not think it would be wise to consolidate the collections on one side of the road. In answer to further questions, Sir John Donnelly said he thought it was most desirable that the Geological Museum in Jermyn Street should be transferred to South Kensington. The library which was now in Jermyn Street would be of great value at South Kensington, and under the present system of division they had to duplicate many of the books. He would undertake to bring this view before the Lord President and the Vice-President of the Council. As to the Art side, the theory that it was better to have a large series of small rooms in which they could classify their objects rather than a series of very large halls or rooms was absolutely impracticable in their case. He was distinctly in favour of residences being provided for some of the officers—say four—either in the same buildings in which the collections were housed or very close to them. There was, he knew, a morbid fear of fire being caused when the residences were in the actual building, but he did not himself believe that this was a very great source of danger.

PHOTOGRAPHY AND TRAVEL.[1]

THE globe-trotter of to-day is almost as notorious for his poor photographs as his ancestor of the Mandeville era was for his traveller's tales. Without instruction in the technical part of his work, and without the geographical training required to teach him what to look for and how to view it, he habitually brings home productions which may be of interest as studies for an impressionist artist, but are of little or no value to the student of nature. Hence it is with particular pleasure that we welcome the republication in a generally accessible form of a selection of Mr. Thomson's magnificent photographs made in China. These were taken before the days of dry plates and snap-shots, when it was necessary to prepare and develop the plates on the spot, and to employ a camera of large dimensions not easy to transport through regions where, to say the least, strangers are not received with overwhelming hospitality.

The photographs are selected so as to give a connected idea of life in China proper in all its aspects, and also to illustrate the natural scenery of many of the provinces and of Formosa. The pictures are so satisfactory from every point of view, that it is no slight to say that the letterpress takes a humbler place when one estimates the value of the book. The text for the most part is descriptive of travel, and illustrative of the photographs, incidents and anecdotes being introduced for that purpose. It would have been more useful if the exact order of the journeys and their date had been mentioned ; and a map might very well have been added to show the situation of the regions visited.

Three introductory chapters deal with the condition of China now and in the past, and with the Chinaman abroad and at home. Having regard to the somewhat acute interest now being taken in China by the nations

[1] "Through China with a Camera." By John Thomson, F.R.G.S. With nearly 100 illustrations. Pp. xiv + 284. Small 4to. (Westminster: A. Constable and Co., 1898.)

of Europe, the perusal of these chapters should prove useful; and so should the description of the various great centres of population on the coast, in the Yangtze valley and Pekin.

Not the least interesting of the photographs is that which, by the courtesy of the publishers, we are able to give here. The illustration shows two ancient astronomical instruments of purely Chinese construction, which stand on the walls of Pekin, with instruments dating from the thirteenth century, and others constructed for the Chinese Government by the Jesuit missionaries of the seventeenth century. The circles of the instruments of the thirteenth century are divided into $365\frac{1}{4}$ degrees to correspond to the days of the year, each degree being subdivided into hundredths, but the later instruments have their circles divided into 360 degrees.

Ancient Chinese Astronomical Instruments.

THE HEIGHTS OF METEORS.

It is perhaps surprising that the heights of meteors, and especially of that class known as fireballs, were not determined with any accuracy until the near approach of the present century. It is true that a few individual attempts were made in this direction but, considering the large number of brilliant meteors which appear every year, it is curious that some systematic attempts were not made at a much earlier date in this direction. It must, however, be remembered that many years ago there were comparatively few astronomical observers, that means of communication were slow, and that the importance of recording these objects as precisely as possible had not been recognised.

The present is perhaps an appropriate period to refer to this subject, for it was in 1798, just a century ago, that the first systematic attempt was made (by Brandes at Leipzic, and Benzenberg at Dusseldorf) to determine the heights of meteors. Schröter had in 1795 seen a shooting-star (in his reflecting telescope of 20 feet focus), the height of which he estimated at more than four millions of miles! Brandes and Benzenberg, however, found from 22 meteors which they mutually observed in 1798, heights varying between 6 and 140 miles. Brandes instituted some further observations in 1823, and of 62 meteors available for calculation 55 were found to have heights between 30 and 70 miles. On August 10, 1838, M. Wartmann, at Geneva, followed up Brandes's inquiries, and derived the average height of the meteors seen on that occasion as 550 miles, and their velocity 240 miles a second. These values, compared with modern observations, were far less accurate than Brandes's earlier ones.

It is not proposed in this paper to deal fully with the average heights of meteors, for that has been discussed by several authorities. The values are about 76 and 51 miles respectively for the mean elevations at appearance and disappearance. In the case of fireballs, however, they penetrate much deeper into our atmosphere than

the ordinary shooting-stars, and their heights at extinction appear to be about 30 miles. For the present purpose it is intended to refer to the elevation of these objects at the beginning of their visible flights, for this elevation is so considerable in some cases, that, if atmospheric friction induces their combustion, the air extends to a much greater distance from the earth than is ordinarily supposed.

It is not at all a rarity to find meteors which, at the instant of their first appearance, were more than 100 miles in height. I have looked through various lists of the computed real paths of fireballs and shooting-stars, and find that, out of 577 cases, 116 exhibited a beginning height of 100 miles or more, the average being 130 miles. In fact, one meteor out of five displayed incandescence when 100 miles or more from the earth's surface. The materials from which I obtained these results were by Dr. E. Heis, Prof. A. S. Herschel, Prof. G. von Niessl, and myself. The most extreme heights[1] were :—

Date of meteor.	Height at beginning. Miles	Authority.
1868 September 5	483 ...	G. von Niessl.
1849 August 11	216 ...	E. Heis.
1861 July 16	195 ...	A. S. Herschel.
1862 February 2	190 ...	,,
1864 August 10	188 ...	E. Heis.
1883 June 3	188 ...	G. von Niessl.
1861 August 10	184 ...	E. Heis.
1864 July 28	184 ...	,,
1870 September 27	184 ...	G. von Niessl.
1877 March 21	184 ...	,,

The first of these is probably erroneous, for the observations, though numerous, were not accordant, and with such data it is possible for different computers to work out anomalous results. Thus, in the instance of the very long-pathed fireball seen in France and Germany in 1868, three paths have been computed, and they differ widely in their character. These differences are induced by the erroneous observations, and the difficulty of putting a consistent interpretation upon them. The radiant point, as adopted by the various computers, is dissimilar ; and this in itself must occasion a great discordance in the heights, for one observer putting the radiant 5° above the horizon will obviously obtain a lower elevation for the beginning point than another who places it 15° above the horizon—the angle of the meteor's descent being much less. In regard to the fireball of September 5, 1868, the following results were obtained :—

Height at beginning. Miles	Height at ending. Miles	Length of path. Miles	Radiant. ° °	Authority.
483 ...	115 ...	1770 ..	13 — 3 ...	G. von Niessl.
69* ...	191 ...	1000 ...	22 — 12 ...	A. Tissot.
103 ...	65—70 ...	880 ...	18 — 8 ...	A. S. Herschel.

Thus, while von Niessl made it descend from 483 to 115 miles, M. Tissot concluded that it really ascended from 69 to 191 miles! Prof. Herschel's results appear to be the best that can be derived from the materials available, for he obtains normal heights and a slight ascent of the meteor just before extinction. Its enormous length of path is quite beyond dispute.

In every instance where the observations are very inconsistent, it is clear that the results of investigations of this kind must depend largely upon the interpretation put upon them. And for strictly scientific purposes the real paths derived from such materials are of little use, for any critical deductions or trustworthy comparisons cannot be made from them. The instance above alluded to furnishes, however, a very exceptional case ; but it has been selected in proof of the great uncertainty attaching to deductions based upon conflicting observations.

It appears that about 20 per cent. of meteors are at least 100 miles high at the instant of their first visible apparition. This conclusion rests upon a considerable number of results, including a large proportion of fireballs, and may be trusted within small limits of error. From the materials I have examined, I believe the actual height at first appearance of a meteor is *very rarely* as much as 150 miles, and that it seldom reaches beyond 130 miles.

It is singular that in 1897 I found unusual elevations for several meteors, in fact 9 out of 26 (*i.e.* more than one-third), whose real paths I computed, indicated a beginning-height of over 100 miles. These were :—

Date, 1897. h. m.	Mag.	Height at beginning. Miles	Height at ending. Miles	Length of path. Miles	Radiant. ° °
Aug. 2, 11 5½ ...	2	... 112 ...	90 ...	40 ...	40 + 55
2, 11 24 ...	5—4	. 139 ...	124 ...	28 ...	73 + 66
8, 9 15 ...	> ♀	... 133 ...	115 ...	63 ...	52 + 47
9, 13 27 ...	3—1	... 140 ...	77 ...	81 ...	46 + 56
9, 13 52 ...	3	... 131 ...	89 ...	56 ...	58 + 60
9, 14 18 ...	3 × ♀	... 137 ...	75 ...	75 ...	44 + 45
Nov. 13, 15 28 ...	1	... 125 ...	77 ...	75 ...	136 + 9
13, 15 52 ...	1	... 103 ...	59 ...	60 ...	152 + 22
Dec. 12, 8 6 ...	> ♀	... 112 ...	19 ...	151 ...	80 + 23

It is possible that in several of these cases mistakes of identification may have occurred. It must sometimes happen, and especially during the occurrence of a rich shower, that two meteors are recorded at the same time at different places, which show parallax in the right direction, though they are entirely separate objects. Accidental coincidences of this kind would, however, not very often occur, and they would usually be detected by some features of mutual discordance.

There is another point in connection with the first appearance of meteors which merits attention—this is, that observers seldom secure an accurate view of it. The end point is more precisely determined as the eye steadily follows the object until its extinction. But it is rarely the case that even an habitual observer of meteoric phenomena happens to be looking directly to that point of the heavens where a meteor appears. He generally catches it after it has already traversed a section of its flight, and often estimates the extent of its backward trajectory, sometimes adding 5° or 10° to the observed starting-point. Now, a slight error in carrying the visible line of flight too far back may put 30 or 50 miles on the beginning-height of a meteor, especially if it is anywhere near its radiant. It would, therefore, be safer for observers to record the path actually witnessed, without assuming the extent of the portion which escaped them.

But apart from all the uncertainties (which have their outcome in the rough character of the observations) attaching to the subject, it is impossible to put aside the evidence that meteors are sometimes 130 miles and, in extremely rare instances, 150 miles high when they are first visible. There are grave doubts that any meteor has ever been visible at a height of 200 miles. And it is probable that many, if not all, of the instances where heights of about 170, 180 or 190 miles have been found, were due to the commencing points of the flights having been carried too far back by the observers, or that mistakes in the directions have led the computer to adopt erroneous radiants and deduce initial heights considerably in excess of the correct ones.

If photography could step in here, and dispel all the doubts arising from our hurried and often questionable

[1] Other instances of abnormal height might be quoted from the deductions of other authorities, but they are open to serious question. Thus, for the fireball of March 19, 1718, the height at first appearance has been given at 297½ miles ; but Prof. Herschel finds, from a careful rediscussion of the observations, that the meteor began at an elevation of only 80 miles.

* This is the lowest elevation of the meteor as found by M. Tissot, and quoted in British Association Report for 1869, p. 272.

observations, it would be a matter for congratulation. When a meteor is observed by two or more practised observers, the results usually work out very well; but in the case of large fireballs witnessed by a great number of persons, the descriptions are often very conflicting and dubious, and the discussion of such materials is seldom either profitable or trustworthy. W. F. DENNING.

RUDOLF LEUCKART.

RUDOLF LEUCKART, whose death removes one of the most eminent figures in the zoological world, was the son of a bookseller, and was born on October 7, 1822, at Helstedt, which until 1809 had been the seat of one of the universities of the state of Brunswick. A taste for the study of natural history was probably hereditary in the family, for his uncle, Friedrich Sigismund Leuckart (1794–1843), was a zoologist of no mean reputation. The subject of our sketch began his career as an author at a comparatively early age, for whilst still a student at the University of Göttingen he completed the "Lehrbuch der Zootomie" of his teacher, Rudolf Wagner. After serving for a time as assistant in the Physiological Institute of his *alma mater*, he received in 1850 the appointment of extraordinary professor at Giessen, which the genius of Liebig had then raised to a position of great importance among the universities of Germany.

He had already shown what manner of man he was by the publication of two treatises, "Beiträge zur Kenntniss wirbelloser Thiere" (in conjunction with Heinrich Frey, 1847) and "Ueber die Morphologie und Verwandtschaftsverhältnisse der wirbellosen Thiere" (1848), in which the great division *Radiata* of Cuvier was broken up into *Cœlenterata* and *Echinodermata*. He further recognised Metazoa as divisible into six types—*Cœlenterata*, *Echinodermata*, *Vermes*, *Arthropoda*, *Mollusca* and *Vertebrata*—and thus initiated a system which, in its main features, is still maintained at the present day, and must be recognised as a stroke of genius in a young man of some twenty-five summers, working at such an early stage in the history of morphological science.

In 1855 he was made ordinary professor, and in 1870 removed to Leipzig. As a teacher he was clear and stimulating, and his remarkable success in this department of scientific work is attested by the volume issued in commemoration of his seventieth birthday, in which about 139 men of science, including many of the most eminent zoologists of the day, are proud to acknowledge themselves his pupils.

As an investigator he fully realised the promise of his early youth. His knowledge was as accurate as it was extensive, and that to a degree which only becomes comprehensible when we remember that unaided he contributed for nearly forty years a masterly summary of current researches into the natural history of the lower animals to the pages of the *Archiv für Naturgeschichte*. It is clearly impossible to give anything like a detailed account of such an active and many-sided career in a moderate space: let it suffice to recall his insistence on the division of labour in the animal kingdom, his researches on the reproduction of bees and of the Cephalopoda, his recognition of the ciliated organ of Heteropoda and Pteropoda as an osphradium, and his reference of *Neomenia* to the Mollusca.

Undoubtedly, however, his greatest energy was devoted to the study of parasitic life in general and to the life-history of the parasitic worms in particular. He at once recognised the importance of the methods of experimental helminthology introduced by Küchenmeister, and demonstrated the life-history of nearly all the bladder-worms then known by rearing them in suitable hosts. He was the author of epoch-making researches on *Trichina* and on the *Pentastomida*, and contemporaneously with the Englishman, A. P. Thomas, worked out the life-history of the Liverfluke. His work on the "Parasites of Man," the first volume of which has been translated into English, is a perfect cyclopædia of information derived from the writings of others and from his own observations. He has passed away full of years and full of honours, leaving a name which will ever be venerated by zoologists of every tongue and nation.

NOTES.

THE first soirée of the Royal Society, to which gentlemen only are invited, is fixed for Wednesday, May 11.

ON Saturday last (April 2) the Council of University College, London, elected Prof. H. L. Callendar, F.R.S., to the Quain Professorship of Physics, about to become vacant by the resignation of Prof. G. Carey Foster, who in a few months will have held his Professorship in University College for thirty-three years. Prof. Callendar, who has been Professor of Physics in McGill College, Montreal, will enter upon his duties in London in October next.

SIR WILLIAM TURNER, F.R.S., professor of anatomy in the University of Edinburgh, has been elected a corresponding member of the Berlin Academy of Sciences. He has also been elected president of the General Medical Council, in succession to the late Sir Richard Quain.

PROF. H. C. BUMPUS has been appointed director of the laboratory of the United States Fish Commission Station at Wood's Holl.

SIR SAMUEL WILKS has been re-elected president of the Royal College of Physicians of London.

M. RICHET has been elected a member of the Paris Academy of Medicine.

A "JARDIN DE KEW" is to be established in the neighbourhood of Nantes by a rich citizen of that town. The new botanical garden will be planned on the same lines as the Royal Gardens at Kew, and special attention will be given to the cultivation of plants useful in French colonies. It is hoped that the garden will eventually do for French colonial possessions what Kew does for British colonies.

THE Paris correspondent of the *British Medical Journal* announces that a recent decree authorises the University of Paris to borrow 68,000*l.* for the purpose of building laboratories where physical science, chemistry, and natural history will be taught for the benefit of students who are preparing for the examination for Science Certificate. Part of the money is to be applied to the completion of the Laboratory of Vegetable Biology belonging to the University of Paris at Fontainebleau.

THE policy exemplified by the following appointment, announced in *Science*, might be adopted with advantage in this country:—Dr. Charles Wardell Stiles, of the United States Department of Agriculture, has been appointed *attaché* to the United States Embassy in Berlin. Dr. Stiles's duty will be to keep the Agricultural Department informed on important discoveries and other matters of interest to agricultural science, to defend American meats, fruits and other exports against unjust discrimination, and to advise the Secretary of Agriculture from time to time concerning the purity of the food products that are shipped from Germany to the United States. It is said that the appointment of Dr. Stiles will probably be followed by other similar appointments, and it consequently represents an important advance in the application of scientific principles to diplomatic and commercial affairs.

A letter received a few days ago by Prof. Milne from Mr. H. Hamilton, Montserrat, West Indies, contains somewhat startling information. It appears that since the flood of November 29, 1896, which caused great injury to life and property in Montserrat, innumerable earthquake shocks have been experienced. There are several craters and sulphur springs in the island, and it is thought that the mouth of one of the numerous craters was filled up by a landslip caused by the flood referred to, for several shocks of earthquake—the first experienced for a great number of years—were felt on the night of the flood. It is suggested that the filling up of this crater has been the cause of all the earthquakes which have lately occurred in the island. But whatever may be the cause, there is no doubt that since November 1896, the island has been in a very disturbed seismological condition. Scarcely a day passes without a few shocks being felt, and as many as thirty distinct disturbances have often been experienced in one day. On February 15, 18 and 20 of this year, alarming shocks were felt; and it is affirmed that the worst shock on February 15 (11.16 a.m.) was just as severe as the great earthquake of 1843, but being of shorter duration it did not do so much damage. Several buildings have, however, been very badly damaged by the constantly-occurring disturbances, and innumerable cracks have appeared in nearly every stone building in the island. These earthquakes, says Mr. Hamilton, which have been continually felt since November 1896, are causing great anxiety among the inhabitants, and it is feared that the shocks will culminate in a volcanic eruption, or that the numerous stone buildings, weakened as they already are by the continual shocks, must in course of time be thrown to the ground unless the disturbances cease. The whole subject demands scientific inquiry, and it is to be hoped, both in the interests of science and of the people of Montserrat, that the Colonial Office, which has probably received official reports of the earthquakes, will send some one to the island to investigate them.

The numerous cases of enteric fever which have been traced to the consumption of contaminated oysters, clearly points to the need of a change in the present condition of the law relating to the culture of oysters and other shell-fish. For the purpose of submitting a memorial in favour of an alteration of this law, a deputation from the corporations of twenty-five provincial towns, and the London County Council, waited upon the President of the Local Government Board a few days ago. As the law now stands, local authorities have no means of preventing the sale of shell-fish within their districts, even though they possess the clearest evidence that the consumption of the shell-fish has produced typhoid fever, and that the shell-fish is derived from a source known to be contaminated with sewage. In reply to the deputation, Mr. Chaplin said that he considered that the time had arrived for legislative action, and he had been engaged for some time on the measures necessary and appropriate to deal with the matter. As to the dangers which might arise from the sale of infected shell-fish other than oysters, he had not sufficient information to act upon, but with regard to oysters he hoped it would be possible for him soon to take action which would be satisfactory to the deputation.

A holiday course of science lectures and demonstrations will be held in Berlin from Wednesday, April 13, to Saturday, April 23. Lectures on most branches of science have been arranged, and visits will be made to museums and other places of scientific interest.

A meeting of the Institution of Mechanical Engineers will be held on Wednesday and Friday, April 27 and 29. The chair will be taken by the President, Mr. Samuel W. Johnson, who will deliver his inaugural address at the opening meeting. The following papers will be read and discussed, as far as time permits:—"First Report to the Gas-Engine Research Committee: description of apparatus and methods, and preliminary results," by Prof. F. W. Burstall; "Steam Laundry Machinery," by Mr. Sidney Tebbutt.

Attention has already been drawn in Nature to the publication by the Geological Survey of a colour-printed map of the London area and great part of the Weald. This was Sheet 12 of the General Map on the scale of an inch to four miles. We are now able to state that all the fifteen sheets of this map have similarly been issued in the colour-printed form, at a uniform price of 2*s.* 6*d.*, with the exception of the title-sheet, the price of which is 2*s.* The total cost of the map, which if mounted would measure about 8 by 6 feet, is 1*l.* 17*s.*

A correspondent from Bangor writes:—"An instance of a locally acquired habit in birds, on which it would be interesting to collect information from different districts, is afforded by the behaviour of sparrows towards the flowers of garden crocuses. Here in Bangor we have had crocuses blossoming two years in succession without a single flower being eaten off; in gardens at Cambridge, and other places, every flower is pulled to pieces almost before it has fully opened. It would seem that the flowers contain some agreeable flavouring matter which the Bangor birds have (fortunately) not yet learnt to appreciate."

Mr. G. Marshall Woodrow, Professor of Botany at the Royal College of Science, Poona, went to Jeur at the time of the recent total solar eclipse, and made some botanical observations which he communicates to the *Gardener's Chronicle* (March 19). This station was not very suitable for luxurious vegetation, as the daily range of temperature during January was too great, the thermometer ranging from 45° F. to 145° F. and in the shade from 50° F. to 90° F. He, however, collected 130 species, including 26 Gramineæ, 27 Leguminosæ, 14 Compositæ, 9 Acanthaceæ, 5 Asclepiadaceæ, 5 Euphorbiaceæ, 5 Malvaceæ, 5 Cucurbitaceæ, 5 Convolvulaceæ, 2 Solanaceæ, 4 Labiatæ, 2 Urticaceæ, and 2 Capparidaceæ. Of the Gramineæ he mentions that the most frequent one, *Aristida setacea*, was in ripe seed, and it was interesting to observe its manner of distributing them. Its three-branched awns "twist together in such a manner that a perfect sphere is formed by their extended points, and the balls roll hither and thither in every breeze." Another grass of interest is the species Isachne, which has the habit of setting loose its entire inflorescence, a large open panicle of most elegant form, which is rolled about by the wind till it is caught in some bush. This species has an inflorescence larger than any other known; and since it was found while preparing to observe the eclipse, the name *Isachne obscurans* is proposed for it. Prof. Woodrow mentions that as the sunlight began to fade away, owing to the passage of the dark moon, Leguminosæ began to fold up their leaves, as is their manner at evening time.

Mr. H. C. Russell, Government Astronomer of New South Wales, has communicated a second paper to the Royal Society of that Colony, on the subject of icebergs in the Southern Ocean, from reports collected from masters of vessels trading to Sydney and from other sources. The first paper dealt with the icebergs in the South Atlantic which had been reported up to July 1895, and the present paper continues the discussion down to September 1897, during which time the great mass of the bergs has drifted from the South Atlantic to between longitude 40° and 80° in the South Indian Ocean, and have been subsequently reported south-eastward of New Zealand. It is somewhat remarkable that for months at a time very few icebergs were met with by vessels trading to Australia, and their motion into and out of the tracks of vessels made it seem probable that it was affected by the prevalent winds. A reference to the weather

charts showed that when there was a prevalence of north-west wind no ice was reported, while with southerly winds bergs were frequently observed. Mr. Russell states that the records are too short to settle the question, but he is of opinion that by careful study of the winds in connection with the movements of the bergs it will be possible to forecast their positions from the winds prevailing in South Africa and Australia.

The Pilot Chart of the North Pacific Ocean for the month of March, published by the Hydrographer of the United States Navy, contains tables and charts giving the mean temperatures of the surface waters for each quarter and for the year for that part of the North Pacific Ocean comprised between latitude 30° and 60° N., and the west coast of North America and longitude 180° W. The material has been obtained from observations in the possession of the United States Hydrographic Office, supplemented by the data contained in the Russian Admiral Makaroff's work, "The *Vitiaz* and the Pacific Ocean." The coldest region is in 55°–60° N., and 155°–180° W., having for the months of May to September a mean temperature of 43°. In the same longitude, and latitude 50°–55° N., the mean annual temperature is 42°. The warmest region is in latitude 30°–35° N., longitude 140°–165° W., having a mean annual temperature of 68°. The yearly range of monthly temperature is highest in latitude 35°–40° N., longitude 150°–180° W., being 18°·5, and lowest 8°·5, in latitude 30°–35° N., longitude 115°–145° W.

The report of Mr. S. P. Langley, Secretary of the Smithsonian Institution, for the year ending June 30, 1897, has just reached this country. Following the custom of several years, Mr. Langley gives in the body of the report a general account of the affairs of the Institution and its bureaus—the U.S. National Museum, the Bureau of American Ethnology, the International Exchanges, the National Zoological Park, and the Astrophysical Observatory—while more detailed statements by the officers in direct charge of the various branches of the work are given in an appendix. We regret to see, in the report on the work of the National Museum, that the complete manuscript of an important and comprehensive work by the late Prof. Cope on the reptiles of North America, based on the museum collections, is withheld from the printer for want of funds for its publication, and at least four others, equally valuable and extensive, now in an advanced stage of preparation. Delay in the publication of these works will prove a hindrance to the progress of American natural history. The Bureau of American Ethnology has been very active. The field operations have been extended into a large number of states and territories, and incidentally into those districts of neighbouring countries occupied by native tribes closely affiliated with the aborigines of the territory now comprised in the United States. During the year covered by the report special attention was given to the classification of the tribes in such manner as to indicate their origin and development, and to this end the rich archives of the Bureau, comprising the accumulations of eighteen years of research, have been subjected to careful study, and important conclusions have been reached. The International Exchange Service continues to increase; and the fact that exchanges are now made with 28,000 correspondents in every part of the civilised world demonstrates, to some degree, the far-reaching influence of the Institution. The National Zoological Park has been improved by the construction of roads and a new bridge; but the buildings and enclosures of the Park are altogether inadequate, and there are no funds to supply the wants. Among the needs are suitable houses for the preservation and care of birds, a vivarium for small animals, and ponds for aquatic birds and mammals. The operations of the Astrophysical Observatory have consisted chiefly in experiments in the bolographic analysis of the infra red solar spectrum. The report upon this work has been completed; and it contains, in addition to introductory, historical, descriptive, and theoretical matter and accounts of subsidiary investigations, tables of positions of 222 absorption lines in the infra-red solar spectrum in terms of angular deviations and refractive indices for a rock-salt prism, and of the approximate wave-lengths corresponding. It is to be hoped that this report, containing results of great interest and value to physical science, will soon be published.

The election of Prof. James E. Keeler, director of the Allegheny Observatory, to the directorship of the Lick Observatory was announced in last week's Nature. We now learn that Prof. Keeler has written a letter to the Chairman of the Allegheny Observatory Committee stating that he is prepared to decline the call to the Lick Observatory if within two weeks 200,000 dollars can be collected for the erection of a new observatory with a thirty-inch telescope, and towards the endowment of a chair of astronomy in the Western University of Pennsylvania. Efforts are being made to obtain this sum of money, and as much as 137,000 dollars has already been subscribed, while Allegheny City has given a site for a new observatory in an elevated position surrounded by parks, and comparatively free from smoke. We wonder how many British cities and citizens would show in such a substantial way their anxiety to keep a distinguished scientific investigator within their borders.

An interesting observation upon the development of a taste for honey by starlings is recorded by Mr. W. W. Smith in the *Entomologist* (April). In a previous note referring to some enemies of humble-bees in New Zealand, Mr. Smith stated that he had observed the newly-introduced starlings killing and conveying humble-bees to their nests to feed their young. The tui or parson-bird (*Prosthemadera novæ-zealandiæ*) has now been detected killing them at Akaroa on Banks Peninsula. The case is remarkable in illustrating how new habits are acquired, or family habits are developed in some species of birds when certain conditions are present. As the tui belongs to the starling family, and is one of the native honey-suckers, it is possible it also was killing humble-bees to feed its young when it discovered the honey-sac of the insects. The tui, while engaged in killing the bees, would discover their honey-sac, which would also lead to a continuance of the habit as a ready means of procuring their favourite food. An analogous case is also presented in some recently acquired habits of the starling. For two seasons Mr. Smith has observed what is undoubtedly an acquired taste and habit in the starling in New Zealand. Like the tui, this bird now frequents the flax-flats and sucks the honey from the richly mellifluous flowers. It appears probable that the eating of the humble-bee's honey-sac by the starlings developed, or is now developing, the taste for honey in these birds.

From the many papers before us dealing with kathodic rays, Röntgen rays, and the closely-allied phenomena of "electro-dispersion," we extract the following:—Prof. Battelli and Dr. Garbasso (*Nuovo Cimento*, vi. 4) examined more closely the action of kathodic rays on insulated conductors, with the view of testing the existence of indeformable rays in the interior of the Crookes' tube. Their results agree with the hypothesis that the different modes of action of kathodic and Röntgen rays depend on the different conditions of the medium in which the conductor is placed.—M. P. de Heen (*Bulletin de l'Académie Royale de Belgique*, 1898, pp. 188, 191) publishes two papers relating to the electro-dispersive power of Röntgenised air, and also of air modified by a Bunsen burner. In the first paper the author obtains, by the Bunsen burner, results which cannot be accounted for on Villari's theory of Röntgenised air, but indicate the existence of a special kind of energy, to which he applies the name *infra-electric*. In the second paper he describes four experiments dealing with the propagation of what

he calls *anti-electric* energy behind shadows. The papers leave us a little uncertain as to M. de Heen's distinction between the terms *infra-electric* and *anti-electric*; "anti"-electricity, we are told, includes both "infra"- and "ultra"-electricity, but the latter we do not see defined, at all events, in these two writings.

FROM Mr. A. A. Campbell Swinton we have received a reprint of his paper on adjustable X-ray tubes, read before the Röntgen Society.—Part iv. (vol. vii.) of the *Atti dei Lincei* contains two papers, one on the cryptoluminescence of metals, by Prof. A. Róiti; the other on the diffusion of Röntgen rays, by Drs. R. Malagoli and C. Bonacini. According to the two latter writers, (1) the two electrodes contemporaneously emit *ortho-kathodic* rays, but that which communicates with the negative pole of the excitor develops them the most intensely; (2) from the electrodes, at a certain stage of rarefaction, there seem to start two cones of radiation, one enclosed in the other or partially separate, carrying opposite charges; both are displaced by magnets subject to the same laws; (3) the violet anodic light, like the ortho-kathodic rays, is intensely affected by magnetic action, but it follows the opposite law, behaving like an electric current from the anode to the anti-anode; (4) it seems to follow that the anti-anodic system of Maltèzos is, perhaps, only a feeble anti-kathodic system, for between the two systems there is identity rather than mere analogy, and that not only in their effect on the glass.—The *Bulletin de la Société Française de Physique* (Nos. 108, 111) contains abstracts of two papers by M. Villard, the first dealing principally with the rays which produce the hemispherical illumination of "focus" tubes above the plane of the anti-kathode; the second dealing with the laws of variation of the resistance of a Crookes' tube, the electric attraction and repulsion of the seat of emission, the production of Goldstein's rays, and the nature of the kathodic rays. From their action in reducing crystals, silicates, oxides of copper, and other substances, M. Villard suggests that the kathodic rays are formed of molecules of hydrogen due to the traces of moisture left in the tube.—Dr. Josef R. v. Geitler, of Prague, contributes to the *Wiener Berichte* a paper on electric and magnetic decomposition of kathodic rays. The subject has been somewhat foreshadowed by Birkeland, and the investigation bears close analogy to one published by Prof. J. J. Thomson in October 1897. Like him the author, experimenting on the shadow of a wire placed in the kathodic pencil, has obtained a broadening out of the shadow, which appears bordered by a series of green fluorescent striæ separated by dark interspaces. Dr. Geitler claims, however, that his experiments are in many respects essentially distinct from Prof. Thomson's.

BY the death recently reported from Allahabad of Sir Saiyid Ahmad Khan, Indian Moslems have lost a leader who devoted many years, with great success, to their educational welfare and to the extension of scientific knowledge. He may well be described as the apostle of education to the Mahomedans of India. His institute at Aligarh, with its own printing-press and journal, his Anglo-Oriental college at the same place, on the model of a college of Oxford or Cambridge, for the education of Mahomedans of the upper classes, are splendid monuments to his breadth of mind, his wisdom, and his energy. The following particulars of Sir Saiyid Ahmad's career are from an article in Wednesday's *Times*:—This great leader of his people and pillar of British rule, as he has been called, was born in Delhi in 1817. His ancestors, who claimed descent from the Prophet, are said to have originally come from the Herat Valley, and for several generations held high office in the Court of the Moghul Emperors of Delhi. In 1837, after his father's death, the young man entered the British service in the Court of the Judge at Delhi, and from that time until he finally retired from the service he remained in the judicial branch. It was immediately after the Mutiny also that he threw himself heart and soul into the cause of Mahomedan education, and one of his earliest steps was to establish a translation society which should prepare suitable books, the want of which he greatly felt. A few years later this useful association expanded into the Scientific Society of Aligarh, with its own press, from which translations of numerous works on history and various modern sciences have been issued for the use of Mahomedans. It was after a visit to England in 1870 that he bent his mind to the great undertaking of the Anglo-Oriental College at Aligarh, which was opened in 1873 by Sir William Muir, while the foundation-stone of the building now in existence was laid with much ceremony by Lord Lytton in 1877. Having retired from the service in 1876, Saiyid Ahmad was in 1878 appointed a member of the Viceroy's Council by Lord Lytton, the appointment being renewed for a further period by Lord Ripon. He has also been on the Legislative Council of the North-West Provinces. In 1888 he was made K.C.S.I. For many years past Sir Saiyid Ahmad's home at Aligarh has been the goal of the pilgrimages of many of the greatest personages in India, and his reception by his fellow-Mahomedans when he has gone to the Punjab or to Haidarabad has been semi-regal. His last years were wholly devoted to the prosperity of his college and institute, and most of his journeys have been made on their behalf. Anglo-Indians who knew him best are as enthusiastic in his praise as the Indian Mahomedans. To the end he never changed the main article of his social faith—that education was the one indispensable requirement of Indian Mahomedans if they were to maintain under the British Raj the high position which was their due.

AN interesting address, by Prof. Thomas Gray, on the development of electrical science, in which the history of electrical progress since the beginning of the seventeenth century is traced, is published in *Science* of March 18 and 25.

HERR FREIHERR V. RICHTHOFEN, President of the Berlin *Gesellschaft für Erdkünde*, contributes a note to the *Verhandlungen* on the spelling of Chinese names. With the ordinary German pronunciation, *Kiautschou* represents the Chinese name more correctly than *Kiaotschau*, *Tschifu* than *Chefoo*, *Niutschwang* than *Newchwang*, *Futschoufu* than *Foochowfoo*.

THE whole of the first number of the new volume of the *Mittheilungen von Forschungsreisenden und Gelehrten aus den deutschen Schutzgebieten* is taken up with an exhaustive account of the drum language of the Duala, by Herr R. Betz This method of conversation at a distance reaches a higher development in the Duala region than in any other part of the Kameruns. The paper contains no fewer than 275 examples of signs and phrases.

FROM an advance proof of the tables relating to the output of coal and other minerals in 1897, published by the Home Office, we learn that 202,119,196 tons of coal were mined in the United Kingdom last year. This was an excess of nearly seven million tons over the output for 1896. Next to coal, the largest outputs were:—ironstone, 7,793,168 tons; fireclay, 2,682,472 tons; oil shale, 2,223,757 tons.

PROF. DR. J. WALTHER contributes a further instalment of his studies of deserts to the *Verhandlungen* of the *Gesellschaft für Erdkünde zu Berlin*. Prof. Walther made an expedition into the waste regions of Transcaspia and Bokhara after the Geological Congress at St. Petersburg last year, and describes his observations on the erosive action of wind, of great ranges of temperature, and of the saline deposits in dried-up lakes. The paper forms an important addition to the author's geological work in similar regions of North America and North Africa.

THE "Statesman's Year-Book," edited by Dr. J. Scott Keltie, with the assistance of Mr. I. P. A. Renwick, annually improves in character and increases in usefulness. The volume just published by Messrs. Macmillan and Co. is the thirty-fifth; and it contains in the 1166 pages the latest statistical and other data referring to all the States of the world. The special features this year are maps showing, by means of different colours, the distribution of British commerce throughout the world, a map illustrating the Niger question, and a series of coloured diagrams exhibiting the course of trade in leading countries during the past twenty-five years. Trustworthy information upon all questions of political and commercial geography can be obtained from the volume, which keeps its place as the most handy and complete annual of geographical statistics in existence.

THE additions to the Zoological Society's Gardens during the past week include a Molucca Deer (*Cervus moluccensis*, ♂) from the Molucca Islands, presented by H.G. the Duke of Bedford; a Great-billed Touracou (*Turacus macrorhynchus*) from West Africa, presented by Mr. R. J. Nicholas; two Cambayan Turtle Doves (*Turtur senegalensis*) from West Africa, presented by Sir Edward Burne-Jones; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Captain Francis W. Bate; two Arctic Foxes (*Canis lagopus*) from the Arctic Regions, four Oyster-catchers (*Hæmatopus ostralegus*), European, purchased; a Caucasian Wild Goat (*Capra caucasica*, ♂, juv.) from the Caucasus, received in exchange; a Burchell's Zebra (*Equus burchelli*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SPECTRUM ANALYSIS OF METEORITES.—A research of great interest has been undertaken by Messrs. W. N. Hartley and Hugh Ramage on the wide dissemination of the rarer elements and the mode of their association in the more common ores and minerals. The outcome of this work has led us to believe that the rarer metals are more widely distributed than was ever dreamt of, the authors showing that out of ninety-one iron ores obtained from the Dublin Royal College of Science, thirty-five contained the extremely rare metal gallium, while most of them contained constituents of an unusual character. Thus rubidium was commonly present: the magnetites invariably contained gallium, but no indium; the siderites all contained indium, but lacked gallium. In a more recent research they have investigated spectroscopically numerous meteoric ores, siderolites and meteorites (*Scientific Proc. of the R. Dublin Soc.*, vol. viii. (N.S.) Part vi., No. 68), the range of spectrum being between the wave-lengths 6000 and 3200, and the results they obtained in this case, arranged in tabular form, are of great interest. It is shown that the composition of different meteoric irons is very similar, though the proportions of constituents differ somewhat. Meteoric irons, different varieties of iron ores, and manufactured irons contain copper, lead, and silver. Gallium is a constituent of meteoric irons, but not of all meteorites, and occurs in varying proportions. Sodium potassium and rubidium are constituents of meteoric irons, but only in very small proportions. Meteoric stones, but not the irons, contain chromium and manganese. Nickel was found to be a principal constituent in all meteorites, meteoric irons, and siderolites, cobalt occurring in the two last varieties. The authors describe the chief points of difference between telluric and meteoric iron to be the absence of nickel and cobalt in any considerable proportion from the former, and the presence of manganese. Meteoric irons, on the other hand, contain nickel and cobalt as notable constituents, and, except in minute traces, manganese is absent. In referring to the photographic spectra of iron meteorites obtained by Sir Norman Lockyer from the Nejed and Obernkirchen meteorites, the authors point out that of the two lines, one described as "unknown," and the other as "doubtfully ascribed to iron," the former is certainly, and the latter probably, a gallium line. At the conclusion of their paper the authors give three plates, which reproduce the flame spectra of six metallic irons and three siderolites with comparison spectra.

STELLAR PARALLAXES.—Dr. Bruno Peter, during the years 1887 to 1892, made a series of parallax observations with the Leipzig heliometer. The results of this investigation have been published in vol. xxii. No. 4, and xxiv. No. 3, of the *Abhandlungen der Math.-Phys. Classe der K.S. Gesel. der Wissenschaften*; but Dr. Peter makes a short abstract in the *Astronomische Nachrichten*, No. 3483, which we briefly refer to here. In the following table, which brings together these results very clearly, ε represents the mean error of the parallax, and ε′ that for one evening. In the three references to the star Lal 18115, (1) relates to the preceding component, and (2) to the following one, while (3) deals with the pair as a whole. The last column gives the comparison stars employed in each case.

Star.		Proper motion.	Parallax.	ε	No. of obs.	ε′	Comparison stars.	
	m.	″	″	″		″	°	°
η Cassiopeiæ ...	4	1·20	+0·18	0·030	45	0·15	+57·112	+57·172
μ ,, ...	5·5	3·74	·13	·037	23	·16	53·207	54·241
Lal 15290	8·5	1·97	·02	·043	32	·16	31·1648	30·1620
Lal 18115 (1) ...	8·0		·18	·027	22	·11	} 53·1309	53·1330
,, (2) ...	8·0		·18	·032	21	·12		
,, (3) ...		1·69	·18	·020	43	·11		
δ Ursa Maj. ...	3	1·11	·09	·035	22	·14	52·1389	51·1536
A-Oe. 10603 ...	6·5	1·45	·17	·013	27	·12	50·1707	49·1946
β Comæ	4	1·20	·11	·042	42	·18	28·2207	28·2184
31 Aquilæ ...	5·5	0·96	·06	·015	40	·16	11·3802	12·3929
Bradley 3077 ...	6	2·08	·13	·012	39	·14	56·2956	56·2978

JAMES WATT, AND THE DISCOVERY OF THE COMPOSITION OF WATER.[1]

WHEN your Secretary did me the honour to communicate the wish of the Committee that I should deliver this lecture, he was good enough to send me a list of the names of my predecessors in the position I was invited to occupy, together with a statement of the subjects on which they had addressed you. I confess I read his letter with very mingled feelings. To be asked to form one of such a distinguished company was in itself an honour which I deeply appreciated. On the other hand, it seemed well-nigh hopeless to find any theme associated with the life and work of the great man whose services to humanity we are this day called upon to commemorate, that had not been dealt with by one or other of those who preceded me. Naturally, and as befits the subject, the greater number of those who have spoken on these occasions have been distinguished engineers and mechanicians, and they have been able to speak with a fulness of knowledge, and a weight of authority, on the outcome of the great engineer's labours to which I, who know nothing of engineering or machinery, can have no pretensions.

It occurred to me, however, on reflection, that there was one incident in Watt's career, which, so far as I could learn, had not been handled by any one of those whom you have invited to appear here, and to which, as it comes within my own province, I thought I might venture, without presumption, to engage your attention. I was the more impelled to select it in that it illustrates one side of Watt's intellectual activity which those who regard him only as an inventor and a mechanician are apt to undervalue or lose sight of altogether. It serves, too, to throw additional light upon his mental character and moral worth, and thus enables us to form a fuller and more just appreciation of the attributes of the man we wish to honour. The incident, in a word, relates to Watt's share in the establishment of the true view of the chemical nature of water.

To the historian of science this is doubtless an old story, on which it would be difficult to say anything new. The literature concerned with it occupies many volumes, largely owing to the circumstance that it has given rise to a controversy which has engaged the active interest of some of the strongest and subtlest intellects of this century. Some of the disputants have been men like Brougham, Jeffrey and Muirhead, skilled in the arts of advocacy and in the faculty of eliciting and weighing evidence, who have stated their conclusions with all the "pomp and circumstance" of a judicial finding; others are men like Arago, Dumas, Harcourt, Whewell, Peacock, Kopp, George Wilson,

[1] The Watt Memorial Lecture, delivered in the Watt Memorial Hall, Greenock, on March 11, by Prof. T. E. Thorpe, LL.D., F.R.S.

eminent in science and literature, who have defended their convictions with great power, ample knowledge, much argumentative force, and occasional eloquence. At one time the contest was waged with no little fury and bitterness; it threatened, indeed, like the famous controversy on the proper form of a lightning-conductor during Sir John Pringle's presidency of the Royal Society, or like the equally famous controversy on the discovery of the planet Neptune, to attain the dignity of a national question, far more acute, I should imagine, than that which has just occasioned all right feeling Scotchmen to approach the Queen in Council on the subject of Scotland's proper place and designation in Imperial concerns.

But the acrimony and ill-feeling have happily long since passed away. There is no longer any need to discuss the question either as an advocate or as a partisan. What I shall attempt to-night is to treat it dispassionately, and, within the compass of an hour, to assess, as impartially as I am able, Watt's true place in regard to this discovery.

It was, indeed, an epoch-making event. The discovery of the composition of water was as momentous for science as the greatest of Watt's inventions was for social and economic progress. The very fact itself, apart from all that flowed from it, was of transcendent interest. But to those who had eyes to see, its supreme importance was in its fruitful and far-reaching consequences. It signified nothing less than the passing away of an old order of things, the downfall of a system of philosophy which had outlived its usefulness, in that it no longer served to interpret natural phenomena, but which was rather a hindrance and a stumbling-block to the perception of truth. The discovery at once led to the inception of a more rational and more truly comprehensive theory, which not only explained what was already known, in a fuller, clearer and more intelligible manner, but pointed the way to new facts hitherto undreamt of, which, in their turn, served to strengthen and extend the generalisation which led to their discovery. No wonder, then, that those who loved and revered Watt, and who were rightly jealous of his honour, should have sought to do all in their power to vindicate what they honestly conceived to be his just title to so signal and so fundamental a discovery.

No man has a juster claim to be regarded as a scientific man, in the truest and noblest sense of that term, than James Watt. The scientific spirit was manifest in him even in boyhood. The very circumstances of his condition, his weakly frame, the solitariness of his school-life, and the early habits of introspection thus induced in a mind forced to feed only on itself, served to strengthen and develop the instinct. Even his early struggles, and the jealousy of the Glasgow Guilds which forbade him to practise his trade in the burgh in which he had not served an apprenticeship, conduced to mould his character and to determine the bent of his mind. Hard and illiberal as it seemed at the time, the *Zunftgeist* which drove him to the shelter of the old College in the High Street, and secured for him the abiding friendship of Black and Robison, was in reality the most fortunate circumstance in his career. It brought him directly under the influence of one of the greatest natural philosophers of his age, and so stamped him permanently as a man of science. It would not be difficult to trace how this influence reacted upon all that Watt subsequently did—from the time of his earliest speculations on the loss of energy in Newcomen's engine down to the very last of his mechanical pursuits in the dignified retirement of Heathfield Hall. He approached the question of the improvement of the steam-engine as a scientific problem, and under the direct inspiration of the doctrine of the great discoverer of the principle of latent heat. It was this same mental attitude towards scientific truth, the same receptivity for scientific doctrine, the same love of pondering over and speculating upon the true inwardness of things that brought him the friendship of Priestley, Withering, Wedgwood and De Luc, and that ultimately made him a cherished member of the foremost scientific academies of the world. It will occasion little surprise to one who has formed a true perception of his character to learn that Watt was wont, even at periods of great mental depression, and of physical suffering, amidst all the toil and anxious worry of a business surrounded with difficulties, to find peace in the contemplation of natural phenomena, and to spend time in philosophical speculation. The shrinking, diffident man, in thus communing with himself and with nature, followed a true and constant impulse to withdraw from the strife and turmoil of the world, and to seek his pleasure and his rest in the silent contemplation of natural truth. No one can look upon that contemplative face without being struck with its expression of philosophic calm. What deep, genuine pleasure these communings brought to the harassed man may be gleaned from his correspondence. In truth, nature intended Watt to be a philosopher of the pattern of Boyle, or Newton, or Dalton; it was destiny that drove him into the world of affairs where, as he said, he was out of his sphere. It is necessary to dwell for a moment on this aspect of Watt, in order to form a just appreciation both of his position and of his merits in regard to the great chemical truth with which his name is associated.

The man of action is apt to regard the contemplative mind with something akin to contempt. I once heard a bustling, busy man, the head of a large engineering establishment, who had enjoyed the good fortune to be a pupil of Thomas Graham, say of that distinguished philosopher that he was the laziest man he had ever met. He did not say he "ever knew"—for how little he really knew of Graham was evident from the fact that at the period to which he referred Graham's thoughts were deeply occupied with some of the most memorable of his investigations.

It was in one of these contemplative moods—in what he himself styled his periods of excessive indolence—and as it happened at the very time that the Soho firm was struggling to protect itself against the unprincipled horde that was seeking to infringe Watt's fundamental patent, that he occupied himself with turning over in his mind the outcome of one of his friend Priestley's multitudinous experiments. Watt had long held the view that air was a modification of water, or, as he expressed it in a letter to his friend Black, under date December 13, 1782, that, "as steam parts with its latent heat as it acquires sensible heat, when it arrives at a certain point it will have no latent heat, and may, under proper compression, be an elastic fluid nearly as specifically heavy as water": at which point he conceived it would again change its state and become air. As he then relates, he sees a confirmation of this opinion in an experiment of Priestley's made, as he says, "in his usual way of groping about." "As he [Priestley] had succeeded in turning the acids into air by heat only, he wanted to try what water would become in like circumstances. He undersaturated some very caustic lime with an ounce of water, and subjected it to a white heat in an earthen retort. . . . No water or moisture came over, but a quantity of air, equal in weight to the water . . . a very small part of which was fixed air, and the rest of the nature of atmospheric air. . . . He has repeated the experiment with the same result."

About a fortnight later Priestley wrote that he was able to convert water into air "without combining it with lime or anything else, with less than a boiling heat, in the greatest quantity, and with the least possible trouble or expense." He added that "the method will surprise more than the effect," but that he would defer "the communication of the hocus pocus of it" until such time as Watt should give him the pleasure of his company in return for the pleasure he was to give Watt in speculating on the subject.

These experiments, as we shall see in due course, were wholly fallacious; in following them up with his wonted ardour, Priestley quickly found himself in a maze of contradictions, and ultimately discovered that this seeming conversion was absolutely mythical.

It may be useful, however, to make one or two comments on these passages at the present juncture. In the first place Watt's opinion as to the relation of water and air, although founded, as he thought, upon a more philosophical basis, simply embodied the teaching of the schoolmen. The notion that the so-called four elements were mutually convertible, or were in essence identical, ran through the doctrine of twenty centuries of teachers. Despite the onslaughts of the Spagyrists, and the author of the "Sceptical Chymist," it permeated the literature of natural philosophy down to the very beginning of this epoch. Watt was insensibly swayed by a belief which had descended to him, like the undying germ, through the ages, and he could no more shake himself free of it than he could get rid of the influence of heredity. The very mode in which he, in common with men of his time, uses the term "air," is an indication of the manner in which the ancient creed limited and cramped his thought. He knew that there were various "airs," but it is very doubtful if he realised that they were essentially different substances. There is abundant evidence in the few chemical papers that he published, and especially in his letters to Black, Priestley, De Luc, Kirwan and others, that he regarded them

all as constituted of the same matter, affected by attributes more or less fortuitous and accidental. Thus, all the varieties of inflammable air were at bottom identical, with properties modified by their origin or their varying content of the hypothetical principle phlogiston—that is the principle that was assumed to make them burn.

From Watt's published correspondence we are able to judge how he regarded Priestley's further work on this so-called conversion of water into air. He admits that the facts are "in some degree contradictory to each other." The apparent conversion would seem to depend upon the material of the vessel in which it was made. In a glass vessel no air was produced, nor was any found in a gun-barrel when the distillation was done slowly; but when confined by a cock, "and let out by puffs, it produces much air; which," says Watt, "agrees with my theory, and also coincides with what I have observed in steam-engines. In some cases I have seen the tenth of the bulk of the water, of air extricated or made from it." Davy once said "the human mind is governed not by what it knows, but by what it believes; not by what it is capable of attaining, but by what it desires." However willing to catch at anything in support of his belief, it is possible that Watt might have been led to doubt the soundness of Priestley's experiment, if an apparent and wholly-unlooked for confirmation of it had not arisen.

To make the account exact, and in view of what is to follow, it is necessary to go back a little, in point of time. In the spring of 1781, Priestley performed what he styled "a mere random experiment made to entertain a few philosophical friends." It was practically a repetition of Volta's experiment of firing a mixture of the inflammable air from metals, that is, hydrogen, with common air in a closed glass vessel by means of the electric spark. After the deflagration the vessel was found to be hot, and on cooling its sides were observed to be bedewed. Neither Priestley nor any of his philosophical friends seem to have paid particular attention to the deposit of moisture, or, at all events, if they did they failed to perceive its significance. One of them, however, Mr. John Warltire, a lecturer in natural philosophy in Birmingham, imagined that the experiment might afford the means of showing whether heat was ponderable or not; and accordingly he repeated it, using for greater safety a copper globe, weighed before and after the passage of the spark. A minute loss of weight was always noticed, "but not constantly the same; upon the average it was about 2 grains."[1]

Priestley, who, with Withering, was present when the experiments were made, confirmed the apparent loss of weight; but he added, with a caution that was not characteristic, that he did not think "that so very bold an opinion as that of the latent heat of bodies contributing to their weight should be received without more experiments, and made upon a still larger scale."

Priestley's volume—the sixth in the series—was published in 1781, and was certainly known to Watt; indeed, in the Appendix are printed a number of observations made by him apparently as the work was passing through the press. Although, therefore, he must have had his attention drawn about this time to the formation of the dew in Priestley and Warltire's experiment, there is nothing to show that he attached any importance to the circumstance, or that, if he did, he dissented from Warltire's conclusion that common air deposits its moisture when it is phlogisticated.

For some time previous to the publication of Priestley's book, Mr. Cavendish was engaged upon an inquiry "to find out the cause of the diminution which common air is well known to suffer by all the various ways in which it is phlogisticated, and to discover what becomes of the air thus lost or condensed." In other words, it was an investigation to determine the changes experienced by air when bodies were made to burn in confined portions of it. On the appearance of Priestley's book he repeated Warltire's experiment, thinking "it worth while to examine more closely, as it seemed likely to throw great light on the subject I had in view." He confirmed the observation on the formation of dew; but although he made the experiment on a larger scale, and with varying proportions of the two airs, he was unable to satisfy himself as to the loss of weight after the explosion. As the result of a number of trials, made both with the inflammable air from zinc and from iron—that is, hydrogen—and mixed with common air in the proportion of 423 measures of the inflammable air to 1000 of common air, he says, "we may safely conclude that when they are mixed in this proportion, and exploded, almost all the inflammable air and about one-fifth part of the common air lose their elasticity, and are condensed into the dew which lines the glass." In order to examine the nature of this dew, large quantities of the hydrogen were burnt with two and a half times its volume of common air, and the product of the combustion was caused to pass through a long glass tube whereby it was condensed. "By this means 135 grains of water were condensed in the cylinder [*i.e.* the tube], which had no taste nor smell, and which left no sensible sediment when evaporated to dryness; neither did it leave any pungent smell during the evaporation; in short, it seemed pure water. . . . By the experiments with the globe, it appeared that when the inflammable and common air are exploded in a proper proportion, almost all the inflammable air and nearly one-fifth of the common air, lose their elasticity, and are condensed into dew. And by this experiment it appears that this dew is plain water, and consequently that almost all the inflammable air and about one-fifth of the common air are turned into pure water."

The idea that common air was for the most part a mixture of two gases—oxygen or the dephlogisticated air of Scheele and Priestley, and nitrogen or the mephitic air of Rutherford, the azote of Lavoisier—was familiar to chemists at this period as the result of the teaching of Scheele and Lavoisier, and there is reason to suppose that this opinion was shared by Cavendish. He had been engaged for some time past in an elaborate inquiry into the constitution of atmospheric air, the results of which admitted of no other interpretation than that common air was composed of two different gases, mixed or combined in constant relative proportions. It is true that in the memoir containing the results of his inquiry he nowhere directly gives his estimate of these relative quantities, but, from the data he affords, it is easy to deduce the amount and the constancy of the proportion. Cavendish's papers are characterised by remarkable conciseness and brevity; an experiment which must have involved the putting together of elaborate and complicated apparatus, and which must have occupied considerable time in its performance, is described in a few lines, and hence it is not always possible to gather with certainty the precise disposition of the arrangements. He never sets out his reasons or his conclusions with any great amount of detail, and his published words occasionally give little indication of his line of thought. But that he clearly recognised that only one portion of common air was concerned in the formation of water, and that this portion was the dephlogisticated air, or oxygen, is obvious from the next series of experiments in which he fired a mixture of about two measures of hydrogen and one measure of oxygen in a previously exhausted glass globe furnished with an apparatus for firing air by electricity. When the included air was fired, almost all of it lost its elasticity, so that fresh quantities of the explosive mixture could be introduced and the process repeated until a sufficient quantity of the moisture was obtained for examination. In these experiments Cavendish clearly and definitely demonstrated that the weight of the water was practically equal to the weight of the mixed gases which had combined to form it. In some cases the water was perfectly neutral in its reaction; in others it was slightly acid, and the cause of this acidity caused Cavendish much experimenting, but he is never in any doubt as to the main result; he says distinctly, "if those airs could be obtained perfectly pure, the whole would be condensed." Now if Cavendish had published this main result at the time he obtained it, namely in the summer of 1781, or even if he had formally communicated it to one of the meetings of the Royal Society during the ensuing session, there would have been no Water Controversy. But even if he were ready, it was characteristic of him to delay, not from inertia or indolence, but from a morbid shyness, an unconquerable reticence, which constantly led him to postpone any public announcement of his work. He had the additional, and to him all-sufficient, reason that he had not yet worked out the cause of the occasional acidity of the water. What he did, however, was to communicate the facts of his experiments to Priestley, as Priestley himself states in a subsequent paper published in the *Philosophical Transactions* for 1783. When or how he communicated them to Priestley does not appear, nor have we any means of knowing precisely what was said. Something, however, on this point may be inferred from what

[1] The account of these experiments is given in a letter to Priestley, and constitutes No. v. of the "Appendix to Priestley's Experiments and Observations relating to various branches of Natural Philosophy, &c.," vol. ii. (Birmingham, 1781).

Priestley proceeded to do. It appears from a letter to Wedgwood that he repeated Cavendish's experiment during the March of 1783. It will be remembered that he was at this period engaged on his experiments on the seeming conversion of water into air. He had obtained a number of contradictory results which had led Wedgwood, as far back as the previous January, to put certain sagacious queries, which doubtless in the end had their effect in opening Priestley's eyes to the origin of his mistake. But at the time both he and Watt were seeking for fresh evidence to substantiate the possibility of this conversion. Now just as Cavendish thought that Warltire's experiment might throw light upon the particular matter on which he was engaged, so Priestley considered that Cavendish's work might afford evidence, indirect it is true, but still evidence, of the intimate connection between water and air. Cavendish had, he thought, established the converse of the proposition which he and Watt were seeking to prove in showing that "air," or rather certain kinds of "air," could be converted into water weight for weight. It was no longer the original Warltire experiment of exploding common air and hydrogen. Cavendish had indicated the particular kinds which were really concerned in the phenomena, and it was the Cavendish experiment, pure and simple, which he proceeded to repeat. This is obvious from what he says: "Still hearing of many objections to the conversion of water into air, I now gave particular attention to an experiment of Mr. Cavendish's concerning the *reconversion* of air into water by *decomposing* it in conjunction with inflammable air." Priestley here used the word "decomposing" in a sense contrary to that which the context implies; but that he is consistent in so using it is evident from what follows, and also from similar expressions to be found in his correspondence. But although he professed to repeat Cavendish's experiment, he neglected to do so in Cavendish's manner. He says: "In order to be sure that the water I might *find in the air was really a constituent part of it*, and not what it might have imbibed after its formation [*i.e.* by contact with the water of the pneumatic trough], I made a quantity of both dephlogisticated and inflammable air, in such a manner as that neither of them should ever come into contact with water, receiving them as they were produced in mercury; the former from nitre, and in the middle of the process (long after the water of crystallisation was come over), and the latter from perfectly made charcoal. The two kinds of air thus produced I decomposed by firing them together by the electric explosion, and found a manifest deposition of water, and to appearance in the same quantity as if both the kinds of air had been previously confined by water.

"In order to judge more accurately of the quantity of water so deposited, and to compare it with the weight of the air decomposed, I carefully weighed a piece of filtering-paper, and then having wiped with it all the inside of the glass vessel in which the air had been decomposed, weighed it again, and I always found, as nearly as I could judge, the weight of the decomposed air in the moisture acquired by the paper. . . . I wished, however, to have had a nicer balance for the purpose: the result was such as to afford a strong presumption that the air was reconverted into water, *and therefore that the origin of it had been water.*"

These passages, when compared with the accounts given of his own work by Cavendish, strikingly exemplify the difference in the character of the two experimentalists. It would be difficult to pack a greater number of errors into a couple of paragraphs than are contained in these sentences. The expressions in italics show that Priestley wholly failed to comprehend the true origin of the water. In his laudable anxiety to free the two gases from extraneous moisture, he committed blunder after blunder. His method of obtaining the oxygen was bad; that of procuring the inflammable air was worse. Both the gases must have been highly impure, and it was a physical impossibility that they should have given their aggregate weight in water, even after making every allowance for Priestley's crude and imperfect method of determining it.

Bad, however, as the experimental work was, what it appeared to teach was not lost on Watt: it clearly proved to him that water and air were mutually convertible. How the theory took shape in his mind is evident from the terms in which the two series of Priestley's experiments are coupled together in his letters to Gilbert Hamilton, to De Luc and to Black. Each set is regarded as complementary to the other, and, both taken together, are held to prove that air and water are mutually convertible, and are therefore essentially the same. Under date April 21, 1783, he tells Black that "Dr. Priestley has made more experiments on the conversion of water into air, and I believe I have found out the cause of it; which I have put in the form of a letter to him, which will be read at the Royal Society with his paper on the subject." He then proceeds to give Black a summary of the three sets of facts, or supposed facts, on which he bases his generalisation, and he makes use of these significant words: "In the deflagration of the inflammable and dephlogisticated airs, the airs unite with violence—become red-hot—and on cooling, totally disappear. The only fixed matter which remains is *water;* and *water, light* and *heat* are all the products. Are we not, then, authorised to conclude that water is composed of dephlogisticated and inflammable air, or phlogiston, deprived of part of their latent heat, and that dephlogisticated, or pure air, is composed of air deprived of its phlogiston, and united to heat and light; and if light be only a modification of heat or a component part of phlogiston, then pure air consists of water deprived of its phlogiston and its latent heat." Very similar turns of expression and trains of reasoning are to be met with in other letters to his friends, written at about the same period. In all it is abundantly clear that, whatever may have been his surmises as to the real nature of water, it was the conception of the mutual convertibility of air and water that was uppermost in his mind. These passages, however, constitute Watt's claim to be regarded as the true and first discoverer of the compound nature of water.

Three days after the letter to the Royal Society was written, or rather dated, there came a bolt from the blue in the form of a letter from Priestley to Watt. "Behold," it said, "with surprise and with indignation the figure of an apparatus that has utterly ruined your beautiful hypothesis, and has rendered some weeks of my labour in working, thinking, and writing almost useless." The doubts of Wedgwood, certainly no mean authority on the properties of baked clay, had, in fact, led Priestley to devise an experiment by which it was proved beyond all doubt that this seeming conversion of water into air was really due to an interchange of steam and air, effected by diffusion through the porous material of the retort. Well might Priestley cry to De Luc, "We are undone!" Watt's faith in the "beautiful hypothesis" was no doubt rudely shaken, but it was not shattered. In his answer to Priestley he denied that it was ruined: "It is not founded," said he, "on so brittle a basis as an earthen retort." Priestley, however, would have none of it: theories with him—always excepting the all-comprehensive one of phlogiston, which was the head and front of his creed, as, indeed, of his subsequent offending—had at no time much value, for, as Marat said of Lavoisier, he abandoned them as readily as he adopted them, changing his systems as he did his shoes. Indeed, he rather prided himself on his capacity for quick change. "We are, at all ages," he once said, "but too much in haste to *understand*, as we think, the appearances that present themselves to us. If we could content ourselves with the bare knowledge of new facts, and suspend our judgment with respect to their causes, till by their analogy we were led to the discovery of more facts, of a similar nature, we should be in a much surer way to the attainment of real knowledge." With a candour all his own, he immediately added: "I do not pretend to be perfectly innocent in this respect myself; but I think I have as little to reproach myself with on this head as most of my brethren; and whenever I have drawn general conclusions too soon, I have been very ready to abandon them. . . . I have also repeatedly cautioned my readers, and I cannot too much inculcate the caution, that they are to consider new *facts* only as discoveries, and mere *deductions* from these facts, as of no kind of authority; but to draw all conclusions, and form all hypotheses, for themselves."

Watt's mind was of a very different cast. He did not lightly adopt opinions; his convictions were slowly and deliberately formed, and were retained with a corresponding tenacity. But, all the same, he eventually thought it prudent to withdraw his letter; and three days prior to the reading of Priestley's paper, which accompanied it, Priestley informed Sir Joseph Banks of Watt's desire that the letter should not be publicly read. That it was withdrawn on account of what Watt calls Priestley's "ugly experiment," is stated by him in a letter to Black, on the ground that this experiment rendered "the theory useless in so far as relates to the change of water into air. . . . I have not given up my theory [that is, as to the mutual convertibility of water into air], though neither it nor any other known one will account for this experiment."

In the meantime Cavendish had been pursuing his inquiries,

and towards the end of this year (1783) he was prepared to give the explanation of the cause of the disturbing factor in his proof of the real nature of water—that is, the origin of the occasional and apparently haphazard presence of small quantities of nitric acid. This he demonstrated to be due to the difficulty of excluding a greater or less quantity of atmospheric nitrogen from the gases employed; and he determined the conditions under which this nitrogen led to the formation of the acid, the true nature of which he thus for the first time established. The account of his labours was read to the Royal Society on January 15, 1784.

In the previous autumn, however, disquieting rumours reached this country that the French philosophers, and chief among them Lavoisier, were poaching upon the English preserves. The circumstance is alluded to in a letter from Watt to De Luc, dated November 30, 1783. "I was at Dr. Priestley's last night. He thinks, as I do, that Mr. Lavoisier, having heard some imperfect account of the paper I wrote in the spring, has run away with the idea and made up a memoir hastily, without any satisfactory proofs. . . . I, therefore, put the query to you of the propriety of sending my letter to pass through their hands to be printed; for even if this theory is Mr. Lavoisier's own, I am vain enough to think that he may get some hints from my letter, which may enable him to make experiments, and to improve his theory, and produce a memoir to the Academy before my letter can be printed, which may be so much superior as to eclipse my poor performance and sink it into utter oblivion; nay, worse, I may be condemned as a plagiary, for I certainly cannot be heard in opposition to an Academician and a financier. . . . But, after all, I may be doing Mr. Lavoisier injustice."

That Lavoisier did get some hints, and possibly even through the medium of Watt's letter, is beyond all question. The fact that he was informed of Cavendish's work is specifically stated in Cavendish's memoir in a passage interpolated by Blagden, the Secretary of the Royal Society and Cavendish's assistant and amanuensis, who himself told Lavoisier. The whole of the circumstances are set out in detail in a subsequent letter which Blagden addressed to the editor of the *Chemische Annalen* in 1786. That it was known to be Cavendish's experiment that was being thus repeated, is confirmed by a letter from La Place to De Luc, dated June 28, 1783, in which we read: "Nous avons répété, ces jours derniers Mr. Lavoisier et moi, devant Mr. Blagden, et plusieurs autres personnes, l'expérience de Mr. Cavendish sur la conversion en eau des airs dephlogistiqués et inflammables, par leur combustion. . . . Nous avons obtenu de cette manière plus de $2\frac{1}{2}$ gros d'eau pure, ou au monis qui n'avoit aucun caractère d'acidité, et qui étoit insipide au goût; mais nous ne savons pas encore si cette quantité d'eau représente le poids des airs consumes; c'est une expérience à recommencer avec toutes l'attention possible et qui me paroit de la plus grande importance." The phrase "qui n'avoit aucun caractère d'acidité" is of special significance. The French philosophers, and Lavoisier in particular, could with difficulty, as Blagden relates, be brought to credit the statement that when inflammable air was burnt, water only was formed; their preconceptions concerning the part played by oxygen in such a case, led them to suppose that an acid would be produced. Cavendish was familiar with Lavoisier's doctrine, which is connoted in the very word oxygen, which we owe to the French chemists; and it may be that this circumstance was, amongst others, one cause of the pains he took to understand the origin of the acid he occasionally met with. Lavoisier was led to repeat Cavendish's experiment on June 24, 1783; and on the following day he announced to the Academy that by the combustion of inflammable air with oxygen "very pure water" was formed. It is this statement that has been said to constitute Lavoisier's claim to be considered as the true and first discoverer of the composition of water. That he has no valid claim has been implicitly admitted by Lavoisier himself. The eminent Perpetual Secretary of the French Academy, M. Berthelot, is no doubt accurate in regarding June 25, 1783, as the first certain date of publication of the discovery that can be established by authentic, *i.e.* official, documents; but, as I have elsewhere attempted to show, the circumstances under which that priority of publication was secured give Lavoisier no moral right to the title of the discoverer.[1]

Shortly after the reading of Cavendish's memoir to the Royal Society (January 15, 1784), De Luc wrote to Watt, giving an account of its contents, and insinuating that its conclusions had been formed in the light of knowledge obtained from Watt's letter to the Royal Society, which although, as we have seen, not publicly read, had, there is no doubt, been perused by others than Priestley, to whom it was originally addressed. De Luc was, no doubt, a zealous friend, but in this letter his zeal outran his discretion. The letter was, indeed, unworthy of him. He hastens to exculpate Lavoisier and La Place, but makes a charge against the honour and integrity of Cavendish, for which there was absolutely no justification. He stirs up Watt's suspicions, and then seeks to appease them; he rouses his anger, and then counsels him to silence by an argument which shows how wholly he misunderstood Watt. Watt's reply was characteristic: "On the slight glance I have been able to give your extract of the paper, I think his theory very different from mine; which of the two is the right I cannot say: his is more likely to be so, as he has made many more experiments, and consequently has more facts to argue upon. . . .

"As to what you say of making myself *des jaloux*, that idea would weigh little; for were I convinced I had had foul play, if I did not assert my right, it would either be from a contempt of the modicum of reputation which could result from such a theory: from a conviction in my own mind that I was their superior: or from an indolence, that makes it easier for me to bear wrongs than to seek redress. In point of interest, in so far as connected with money, that would be no bar; for though I am dependent on the favour of the public, I am not on Mr. C. and his friends; and could despise the united power of *the illustrious house of Cavendish*, as Mr. Fox calls them.

"You may, perhaps, be surprised to find so much pride in my character. It does not seem very compatible with the diffidence that attends my conduct in general. I am diffident, because I am seldom certain that I am in the right, and because I pay respect to the opinion of others, where I think they may merit it. At present *je me seus un peu blessé*; it seems hard that in the first attempt I have made to lay anything before the public, I should be thus anticipated."

There was no desire on the part of anybody connected with the management of the Royal Society to withhold from Watt his just due; and it was eventually arranged that his letter to Priestley, together with one he subsequently addressed to De Luc, should be publicly read to the Fellows, and they were subsequently ordered to be printed in the *Philosophical Transactions* in such manner as their author might desire. By his directions the two letters were merged together, and they appear as having been read on April 29, 1784, under the title, "Thoughts on the constituent parts of water, and of Dephlogisticated air: with an account of some experiments on that subject. In a letter from Mr. James Watt, Engineer, to Mr. De Luc, F.R.S." The greater part of the "thoughts" are concerned with the dephlogisticated air. What relate to water have already been given in the extracts from his correspondence. The terms in the letter to De Luc, as printed in the *Philosophical Transactions*, are substantially identical with those of the letters to Black, Hamilton, Smeaton and Fry.

I have now given all the essential facts which led to the recognition of the true chemical nature of water, and I have stated, as accurately and as impartially as I could, the relative share of Watt, Cavendish and Lavoisier in their discovery and interpretation. As regards Lavoisier, it cannot be claimed that he was the first to obtain the facts. To Cavendish belongs the merit of having supplied the true experimental basis upon which accurate knowledge could alone be founded. Watt, on the other hand, although reasoning from imperfect and, indeed, altogether erroneous data, was the first, so far as we can prove from documentary evidence, to state distinctly that water is not an element, but is composed, weight for weight, of two other substances, one of which he regarded as phlogiston and the other as dephlogisticated air. It would be a mistake, however, to suppose that Watt taught precisely the same doctrine of the true nature of water that we hold to-day. Nor did Cavendish utter a more certain sound. What we regard to-day as the expression of the truth we owe to Lavoisier, who stated it with a directness and a precision that ultimately swept all doubt and hesitation aside—except to the mind of Priestley, whose "random experiment" gave the first glimmer of the truth.

In this respect the conclusion of Lord Brougham is most just. It was a reluctance to give up the doctrine of phlogiston, a kind of timidity on the score of that long-established and deeply-

[1] Priestley, Cavendish, Lavoisier, and "La Révolution Chimique": the Presidential Address to the Chemical Section of the British Association, 1890; see also "Essays in Historical Chemistry" (Macmillan, 1891).

rooted opinion that prevented Watt and Cavendish from doing full justice to their own theory; while Lavoisier, who had entirely shaken off these trammels, first presented the new doctrine in its entire perfection and consistency.

We thus see that each of these eminent men played an independent and, we may say, an equally important share in the establishment of one of the greatest scientific truths that the eighteenth century brought to light.

As regards Watt, the history of this incident serves to bring out only more clearly what we know to be the true character of the man. It illustrates the vigour of his intellectual grasp, the keenness of his mental vision. At the same time it exhibits his love of truth for truth's sake; his unaffected modesty, and the sense of humility that was not the less real because accompanied by a sense of what his inherent love of rectitude taught was due also to himself. The voice of envy and detraction has not been unheard amongst the strife of partisans in the Water Controversy, but throughout it no syllable has been breathed that reflected even remotely upon his honour and integrity.

SCIENTIFIC SERIALS.

SEVERAL contributions of anthropological interest appear in the January and February issues of *Globus*.—An old Mexican terra-cotta figure in the American Museum of Natural History is described and figured. It was discovered near Texcoco, and represents a warrior in a padded coat of mail. The figure is of life-size, and its workmanship is peculiar to Mexican antiquities.—A description of the temple-pyramid of Tepoztlan, by Dr. E. Seler, contains not only interesting details, but several very good illustrations of the plan and construction of the temple. Tepoztlan is the place where the Mexican kings had their famous pleasure gardens, and the inhabitants have preserved their ancient language and many of their old customs in their mountain home. The temple lies 2000 feet above the town on a cliff. The ruins consist of several buildings of all kinds and sizes, which are suggested to have been the dwellings of the priests. The temple itself has massive walls built of black and red volcanic stone. The inner space is divided into two rooms by a door let in a thick wall. In the inner room was found a rectangular cavity containing coal and two pieces of copal, showing probably that here was the place where the holy fire was burnt. The door leading to the inner room is flanked by two pillars, richly carved, but the most interesting feature of the room is its benches of sculptured stone. In this room stands an idol, and there were found two pieces of sculpture: one a bas-relief painted in dark red, the other a relief of a Mexican king's crown. Altogether, this is a notable discovery; and if it is really the fact that these people have preserved their ancient culture, it is greatly to be hoped that a scientific exploration will be undertaken before it is too late.—Another people of South America is noted in a paper by Dr. Ehrenreich on the Guayaki in Paraguay. Their territory is bounded on the east and south by Parana, on the north by the rivers Acaray and Monday, and on the west by well-wooded hills. Very little is known about them, and only few ethnographical specimens have found their way into museums. The personal possessions of the people consist of a conical-shaped cap made out of a jaguar skin, chains made of pierced teeth and bones of animals, stone axes, bows and arrows, lances made out of the bark of the palm, and a sharp instrument made out of animal bones. Their vessels are particularly remarkable. Some are egg-shaped, and obviously intended to fix in the ground, and most of them belong to the so-called basket pottery. Several illustrations accompany the paper, including three photographs of a Guayaki man. He is very short, with strikingly short legs, long arms, broad shoulders, short neck and large head. They live entirely as huntsmen, without any tillage, and the very primitive character of the race suggests that they, and possibly other tribes on the boundary line of Brazil, would reveal much information of value to the anthropologist.—An account of the Moplahs of the coast of Malabar, by Dr. Emil Schmidt, is exceedingly useful. They are partly of Hindoo and partly of Arabian origin, and the mixture is shown in their customs. In the north the young husband settles in his wife's house, and the woman's right of succession is admitted; in the south, male succession is the rule. A careful study of these mixed peoples is much needed.—Dr. Nehring gives an account of the worship of the ringed snake among the old Lithuanians, Samoyitians and Prussians.—A paper by Mr. C. G. Hoffman, on the Niggers of Washington, contains some notes on the curious superstitious practices of the Voodoo, said to be a survival of the old religion.—Mr. Christian Jensen's paper on the grave mounds and giants' graves in the islands of North Friesland, contains information of special interest to English folk-lorists who have followed Mr. MacRitchie's ingenious explanation of some fairy beliefs.

SOCIETIES AND ACADEMIES

LONDON.

Royal Society, March 10.—"On the Relative Retardation between the components of a Stream of Light produced by the passage of the Stream through a Crystalline Plate cut in any direction with respect to the Faces of the Crystal." By James Walker.

If the surface of the plate be the plane of xy, the positive axis of z being directed inwards, the relative retardation is $T(n_1 - n_2)$, where the velocity of light in air is unity, T is the thickness of the plate, and n_1, n_2 are the positive roots of a biquadratic in n obtained by expressing that $lx + my + nz = 1$ is a tangent plane to the wave-surface. Writing the roots of the biquadratic as series proceeding by powers of $\sin i$, and expressing the coefficients (which are linear functions of $\sin i$) as symmetrical functions of the roots, the terms of the series may in general be determined in succession by means of linear equations, and have the form $\pm \alpha' + \gamma$, $\pm \alpha'' - \gamma$, where

$$\alpha = \alpha_0 + \alpha_1 \sin i + \alpha_2 \sin^2 i + \alpha_4 \sin^4 i + \ldots,$$

and

$$\gamma = \gamma_3 \sin^3 i + \gamma_5 \sin^5 i + \ldots,$$

while the relative retardation is

$$T(\alpha' - \alpha'' + 2\gamma).$$

This method fails when the plate is perpendicular to an optic axis, in which case the biquadratic may be written

$$n^4 + (c_0 + c_2 \sin^2 i)n^2 + b_3 \sin^3 i\, n + a_0 + a_2 \sin^2 i + a_4 \sin^4 i = 0.$$

Neglecting the coefficient of n, the roots are

$$\pm(\pi + \rho),\ \pm(\pi - \rho),$$

π and ρ being series proceeding by even and odd powers of $\sin i$ respectively. Assuming that the actual roots are

$$\pi + \rho + \alpha,\ -\pi - \rho + \beta,\ \ldots$$

the successive terms of the series α, β, γ, δ are determined as in the former method, and, as for terms of the fourth order, have the form

$$\alpha = -\gamma = a_2 \sin^2 i + a_3 \sin^3 i + a_4 \sin^4 i,$$

$$\beta = -\delta = a_2 \sin^2 i - a_3 \sin^3 i + a_4 \sin^4 i,$$

so that

$$\Delta = 2T(\rho + \alpha).$$

Geological Society, March 23.—W. Whitaker, F.R.S., President, in the chair.—The Eocene deposits of Devon, by Clement Reid. A re-examination of the area around Bovey has led the author to think that Mr. Starkie Gardner is probably right in referring the supposed Miocene strata to the Bagshot period. Lithologically as well as botanically the deposits in Devon and Dorset agree closely. The gravelly deposits beneath the Bovey pipeclays are also shown to belong to the same period, and not to be of Cretaceous date. This correction has already been applied by Mr. H. B. Woodward to a large part of the area. The plateau gravels capping Haldon are also considered to belong to the Bagshot period, for they correspond closely with the Bagshot gravels of Dorset to the east, and of the Bovey Basin to the west, and possess peculiarities which distinguish them from any Pleistocene Drift. Several speakers took part in a discussion upon the paper, some agreeing with the author's views, and some were opposed to them.—On an outlier of Cenomanian and Turonian near Honiton, with a note on *Holaster altus*, Ag., by A. J. Jukes-Browne. Although an outlying patch of chalk in the parish of Widworthy was mentioned by Fitton and marked on De La Beche's map, it has not hitherto been described. The tract is about 4½ miles south-west of Membury, 3½ miles east of Honiton, and about 7 miles from the coast at Beer Head.—Cone-in-cone: additional facts from various countries, by W. S. Gresley. Examples of flinty stone in the "fire-clay series" of the Ashby coalfield exhibit "areas of conic structure lying unconformably." In the same stratum of shale are large masses of the same flinty rock, more or less coated with

conic structures, which appear to have been formed out of layers of shale and ironstone. The bending-up of the shale above the nodules and down below them, the close but unconformable covering of Permian breccia, and the staining of the whole section suggests, if indeed it does not demonstrate, to the author that the growth of the cone-in-cone took place subsequently to the deposit of the Permian breccia. Several American and other examples are described, and a series of conclusions are appended to the paper.

PARIS.

Academy of Sciences, March 28.—M. Wolf in the chair.—Preliminary study of a method of estimating carbon monoxide diluted with air, by M. Armand Gautier. It has been shown in previous papers on the same subject, that carbon monoxide is completely oxidised by passing over iodic anhydride at 60°–65°. The present study is concerned with the dilution at which this action ceases. Known volumes of carbon monoxide were mixed with large quantities of air, and the resulting mixture passed over iodic anhydride; the carbon dioxide product was measured by the method of Müntz. It was found that even at dilutions of 1 in 30,000, the quantity of CO present could be accurately determined. Both acetylene and ethylene are oxidised under the same conditions, but only partially, experiments showing that some 10 to 24 per cent. of the former, and 40 to 60 per cent. of the latter were converted into carbon dioxide.—On the use of palladium chloride as a reagent for the detection of minimal quantities of carbon monoxide in the air, and on the transformation of this gas into carbonic acid at the ordinary temperature, by MM. Potain and Drouin. One part of carbon monoxide in 10,000 of air can be detected by this reagent, if it be assumed that no other reducing gas is present, but the method does not yield quantitative results. Atmospheric air containing $\frac{1}{1000}$th part of carbonic oxide, after remaining in sealed flasks for forty-two days, showed no trace of the monoxide, but a nearly equal volume of carbon dioxide. From this it would appear that the monoxide can be slowly oxidised by air at ordinary temperatures.—Observations of Perrine's comet (1898 March 19) made at the Observatory of Paris, by MM. G. Bigourdan and G. Fayet.—Observations of the same comet, made with the large equatorial at the University of Bordeaux, by M. L. Picart.—Observations of Perrine's comet, made at the Toulouse Observatory with the Brunner equatorial, by M. F. Rossard.—Elements of Perrine's comet, by M. J. Lagarde.—Fundamental theorem on the birational transformations with complete coefficients, by M. S. Kantor.—On certain linear functional equations, by M. Lémeray.—Researches of precision on the infra-red dispersion of Iceland spar, by M. E. Carvallo. The measurements agree well with the results of earlier researches, but are accurate to another decimal place.—On the rigorous determination of molecular weights of gases, starting from their densities, and the deviations which they exhibit from Boyle's law, by M. Daniel Berthelot.—Gas engines with high compression, by M. A. Witz. A discussion of the theory of the Diesel engine. — On the Hertzian field, by M. Albert Turpain.—On an iodide of tungsten, by M. Ed. Defacqz. The hexachloride is first prepared by the action of chlorine upon the metal, and this heated to about 400° C. in a current of hydriodic acid. The iodide has the composition WI_2.—Quinolinic bases, by M. Marcel Delépine. Heats of combustion and formation of quinoline, tetrahydroquinoline, quinaldine, and tetrahydroquinaldine. Combination of organic bases with certain oxygen salts. Double salts are described of aniline and toluidine with cadmium, zinc, magnesium, nickel, cobalt, and copper sulphates.—New observations on the evolution of the *Urnes*, by MM. J. Kunstler and A. Gruvel.—On the encephalon of the Glyceræ, by M. Ch. Gravier. In spite of certain peculiarities which are related to the considerable length of the prostomium, the encephalon of the Glyceræ present the same fundamental characters as those of other allied Annelids of which the nervous system has been specially studied.—On the relation between centrosomes and vibratile cilia, by M. L. F. Henneguy.—On the structure of a mycorhizia, by M. Louis Mangin.—On the replacement of a principal stem by one of its ramifications, by M. Auguste Boirivant. When a lateral branch replaces a portion of a principal stem which has been destroyed, it undergoes modifications so profound as to finally more nearly resemble, both in its structure and external appearance, the axis which it replaces, rather than the branch to which it is homologous.—Biochemical preparation of crystallised dioxyacetone, by M. Gabriel Bertrand. By the action of the sorbose bacteria upon glycerine under suitable conditions laid down in this paper, excellent yields of crystallised dioxyacetone are obtained (25 gr. of the latter from 100 gr. of glycerine).—On the treatment of mania by the injection of normal nerve substance, by M. V. Babes.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

BOOKS.—Outlines of Descriptive Psychology: Prof. G. T. Ladd (Longmans).—The Diseases of the Lungs: Dr. J. K. Fowler and Prof. R. J. Godlee (Longmans).—Nippur, or Explorations and Adventures on the Euphrates: Dr. J. P. Peters, 2 Vols. (Putnam).—Simple Lessons in Cookery: M. Harrison (Macmillan).—A Text-Book of Botany: Strasburger, Noll, Schenck, and Schimper, translated by Dr. H. C. Porter (Macmillan).—The Process of Creation discovered: J. Dunbar (Watts).—Respiratory Exercises in the Treatment of Disease: Dr. H. Campbell (Baillière).—Biomechanik erschlossen aus dem Principe der Organogenese: Dr. E. Mehnert (Jena, Fischer).—Fossil Plants for Students of Botany and Geology: A. C. Seward, Vol. 1 (Cambridge University Press).—Bibliography of the Metals of the Platinum Group (Washington).—Philip's Artistic Animal Studies (Outline and Coloured Series), ditto, Fruit Studies, (Philip).

PAMPHLET.—Report of S. P. Langley, Secretary of the Smithsonian Institution, for the Year ending June 30, 1897 (Washington).

SERIALS.—Natural Science, April (Dent).—The Atoll of Funafuti, Part 6 (Sydney).—Sunday Magazine, April (Isbister).—Good Words, April (Isbister).—An Illustrated Manual of British Birds: H. Saunders, 2nd edition, March and April (Gurney).—Contemporary Review, April (Isbister).—National Review, April (Arnold).—Transactions of the Edinburgh Geological Society, Vol. vii. Part 3 (Edinburgh).—Fortnightly Review, April (Chapman).—Psychological Review, Index for 1897 (Macmillan).—Century Magazine, April (Macmillan).—L'Anthropologie, Tome ix. No 1 (Paris, Masson).—Zeitschrift für Physikalische Chemie, xxv. Band, 3 Heft (Leipzig, Engelmann).—Journal of the Royal Agricultural Society of England, Vol. ix. Part 1 (Murray).—Bulletin of the American Museum of Natural History. Vol. ix, 1897 (New York).—Proceedings and Transactions of the N.S. Institute of Science, Halifax, N.S., Vol. ix. Part 3 (Halifax).—Journal of Botany, April (West).

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THURSDAY, APRIL 14, 1898.

HABIT AND INSTINCT.

Habit and Instinct. By C. Lloyd Morgan, F.G.S. Pp. 351. (London: Edwin Arnold, 1896.)

THE substance of this interesting work was delivered in 1896, as a course of Lowell Lectures at Boston, and as lectures in other parts of the United States.

The arrangement of the book is excellent: the first chapter deals with "Preliminary Definitions and Illustrations," the second, third, and fourth with original observations of the author upon the young of many species of birds; the fifth, with observations upon young mammals. These four chapters form the chief material upon which, in the remainder of the volume, a very interesting and important discussion upon animal habits and instincts is carried on, concluding with the consideration, in the twelfth, thirteenth, fourteenth and fifteenth chapters, of the following subjects, which present so many aspects of wide interest:—"The Relation of Organic to Mental Evolution," "Are Acquired Habits inherited?" "Modification and Variation," "Heredity in Man."

In the preliminary discussion in the first chapter a very beautiful example of a complex instinct is afforded in the behaviour of the Yucca moth (*Pronuba yuccasella*).

"The silvery, straw-coloured insects emerge from their chrysalis cases just when the large, yellowish-white, bell-shaped flowers of the yucca open, each for a single night. From the anthers of one of these flowers the female moth collects the golden pollen, and kneads the adhesive material into a little pellet, which she holds beneath her head by means of the greatly enlarged bristly palps. Thus laden, she flies off and seeks another flower. Having found one, she pierces with the sharp lancets of her ovipositor the tissue of the pistil, lays her eggs among the ovules, and then, darting to the top of the stigma, stuffs the fertilising pollen-pellet into its funnel-shaped opening."

"Now, the visits of the moth are necessary to the plant. It has been experimentally proved that, in the absence of the insects, no pollen can get to the stigma to fertilise the ovules, and the fertilisation of the ovules is necessary to the larvæ, which in four or five days are hatched from the insect's eggs. It has been ascertained that they feed exclusively on the developing ovules, and in the absence of fertilisation the ovules would not develop. Each grub consumes some twenty ovules, and there may be three or four such grubs. But the ovary contains some two hundred ovules. Of these, therefore, say, a hundred are sacrificed to the grubs of that moth, through whose instrumentality alone the remaining hundred can be fertilised and come to maturity."

Concerning this elaborate sequence of actions the author points out that they are performed but once in the lifetime of the moth, without instruction, without imitation, and without the guidance which an experience of the subsequent fate of the eggs might provide. The essentially adaptive nature of the sequence is insisted upon.

The relation between what is "congenital" and what is "acquired" is considered in some detail, and by many examples, especially that of the training of falcons, it is shown that the limits of what can be acquired are determined by what is congenital.

"The behaviour of a trained falcon is an adaptation and modification of the hawk's congenital instincts as a bird of prey. The finished performance is part instinct and part habit. The basis is instinctive and congenital; the modification is a matter of acquired habit."

This valuable preliminary discussion of the subject-matter of the volume is summed up in the following statement—

"From the biological point of view . . . instincts are congenital, adaptive, and coordinated activities of relative complexity, and involving the behaviour of the organism as a whole. They . . . are similarly performed by all like members of the same more or less restricted group, under circumstances which are either of frequent recurrence or are vitally essential to the continuance of the race. While they are, broadly speaking, constant in character, they are subject to variation analogous to that found in organic structures. They are often periodic in development and serial in character. They are to be distinguished from habits which owe their definiteness to individual acquisition and the repetition of individual performance."

The author has rendered a great service in thus bringing together the essential characteristics of instinct as opposed to habit in a few clear brief sentences.

The interesting experiments of the author upon the activities and instincts of young birds must be read in full to be properly appreciated. They have a most important bearing upon problems of very wide interest, such as the hereditary transmission of acquired characters, the theories of Protective Resemblance, Protective Mimicry, Warning Coloration, &c. These experiments and observations should be studied carefully by all who either criticise or support the above-mentioned theories. The general results only can here be indicated.

The observations of Douglas Spalding (*Macmillan's Magazine*, February 1873) upon young chickens have been much quoted, but many of his conclusions are here shown to be without sufficient foundation. Thus Lloyd Morgan's observations do not support the conclusion that there is any instinctive recognition of the mother hen by the young chick which sees or hears her for the first time. He does not find the accuracy of aim is at first equal to that recorded by Spalding, and he gives strong reasons for the belief that the evidence of instinctive fear of a bee or a hawk is not due to alarm at these animals as such, but merely one example of the extreme shyness of young birds at any unusual sight or sound.

There is no instinctive knowledge of food or water. Any object of suitable size and within the right distance is struck at; but the chicks are very quick in learning from the experience thus gained. A young chick, two days old, which had learnt to select pieces of yolk of egg, twice seized a piece of orange-peel of about the same size and shape. After this he could not be induced to touch it, and for a time refused yolk of egg. The conspicuous caterpillars of the cinnabar moth, alternately ringed with black and yellow, were thrown to some chicks, which seized but immediately dropped them and wiped their bills. Later in the day the caterpillars were again offered, and only tried once by some of the chicks.

The following day, after they had eaten many edible caterpillars, the cinnabars were again thrown to them, but the lesson had now been learnt by nearly all.

"One chick ran, but checked himself, and, without touching the caterpillar, wiped his bill—a memory of the nasty taste having been apparently suggested by association at sight of the black-and-yellow caterpillar. Another seized one, and dropped it at once. A third subsequently approached a cinnabar as it crawled along, gave the danger note, and ran off. . . . Similarly, moorhen chicks rapidly discriminated between small edible beetles and soldier beetles. Such discrimination is, however, not congenital, but acquired."

This last conclusion is of great importance for the theory of warning colours. If each generation of insect-eating animals has to learn for itself what is fit and what unfit for food, the advantage of conspicuousness to the unfit and of similarity in conspicuousness becomes much greater than under a condition of instinctive discrimination. On this point Lloyd Morgan's numerous experiments seem to leave little doubt. ". . . There does not appear to be any congenital and instinctive avoidance of such caterpillars with warning colours." Of the instinctive avoidance of distasteful insects he says, "I have not found a single instance."

The theory of mimicry, due to H. W. Bates, is also supported by the behaviour of duckling and moorhen chicks which would not touch drone-flies after having been stung by a bee and a humble-bee respectively. There was never any evidence of an instinctive knowledge of the hurtful nature of bees and wasps. A very young bird, after being once stung, is shy for a long time not only of bees, but of various kinds of insects. An older one, after a similar experience, is in the main only shy of the stinging insect and others that closely resemble it.

There is an interesting description of the manner in which the excreta are prevented from fouling the nest, being voided over the edge or carried away by the parent birds. A friend of the author observed that the young of swallows,

"after being fed by their parents, were nudged and pushed until they turned round and voided excrement, which was immediately seized by the parent bird with the tip of the beak, carried away, and dropped outside."

When the present writer was a boy, he (together with his father and sister) witnessed a proceeding on the part of a parent thrush which made a very deep impression upon him. The parent bird was seen to alight on the edge of its nest, and thrust its beak into the gaping bill and deeply down into the throat of one of its young, and draw forth a large black and white worm-shaped object (apparently from $1\frac{1}{2}$ to 2 inches in length), which it then swallowed. The nest was only a few feet away, below the window of a summer-house, which afforded a perfect view of the performance. It is probable that the observation, which has been up to the present time unintelligible to the writer and those friends whom he has consulted, is to be explained as one form of an instinct of which other forms are recorded here.

The earliest activities in walking, diving, and flying are described in a most interesting chapter which proves the extraordinary congenital accuracy with which these complex associated movements are performed. It is argued with great force that the opportunity of watching the movements of older birds does not offer any sufficient explanation of the precision with which they are performed by the young for the first time. "Who ever learnt to do a difficult thing, even passably well, by merely watching it done superbly by another?" The author's observations convincingly demonstrate the truth of the same conclusion; for he watched the first attempts of this kind made by young birds hatched in an incubator. In all these the earliest associated movements were astonishingly accurate, and sometimes, as in the first dive of a startled moorhen chick (p. 64), incapable of further improvement. Speaking of this example the author says,

"though long deferred, here was the instinctive activity in congenital purity and definiteness, and absolutely true to type, for this was the very first time he had ever dived, nor had he ever seen any bird do so."

The precision and freedom with which swimming and diving are first performed seems to be much greater than that with which walking and flying are begun. It is not improbable that the difference is due to the further difficulty introduced by the necessity in the latter case, and especially in that of flying, of sustaining the weight of the body, and of starting and checking its movements, for the first time. It is probably this, rather than the coordination of muscular movement, which explains such hesitation and such feebleness as is at first observed. In other words it is probably the considerable strain thrown upon the muscles for the first time which prevents perfect precision, so that when this additional strain of weight is borne by the water, the accuracy of the earliest coordinated movements is much greater. Nevertheless the example of the *Megapodius*, quoted on p. 76, renders it probable that the movements of flight may be performed with complete success immediately after hatching, when they are necessary for the existence of the species.

All these statements and arguments only refer to the power of sustaining and moving the body in the air under the most favourable conditions. For the countless adjustments to the ever-varying currents of wind, it is held that very considerable individual practice is necessary. Flight in its finished form is "the result of practice and individual acquisition . . . founded on a congenital basis" (p. 78).

The conclusions to be drawn from many of these observations on young birds are summed up in a most interesting manner in Chapter iv. Thus, in the case of the associated muscular movements referred to above,

"what is inherited is a congenital coordination of motor responses under the appropriate conditions of stimulation. Not only is there inherited a given structure of leg or wing, but a nervous system through which there is an automatic distribution of outgoing currents to the several muscles concerned; so that, without learning or experience, they are called into play with nicely graded intensity, and exhibit complex contractions and relaxations in serial order, thus giving rise to instinctive behaviour of an eminently adaptive nature."

In feeding there is

"a similar congenital coordination of motor responses for pecking at a small object within a suitable distance.

But, from the observations, it seems that the selection of certain of these objects and the rejection of others is a matter of individual experience."

With regard to instinctive fear of particular animals or objects, the evidence indicated that it has no existence in relation to

"bees or wasps as such, but that there is a shrinking response, probably instinctive, from *any* largish strange object, especially if it moves vigorously or makes some such noise as buzzing."

An account of further experiments in the same direction is given in the present chapter. There was no instinctive fear of a fox-terrier dog which was trained to remain passive in the presence of the birds.

"Pheasants, partridges, and plovers would peck at his nose as he smelt at them, and run in between his legs."

"Neither chicks, pheasants, nor jays—not even the little fly-catchers—showed any signs of dread of a kitten, nor did chicks of an older cat."

It is also stated that "there is not apparently much difference in the young of wild and tame birds," in this respect. This interesting conclusion, for which much evidence is quoted, differs from that which has been drawn by Dr. Rae (NATURE, July 19, 1883). The whole of the observations on the effects produced by various animals upon young birds tend strongly to support Mr. Hudson's conclusion that the fear of particular enemies is due to experience and tradition (p. 89).

The rapidity with which associations are formed was illustrated in an amusing manner by some ducklings which had their bath in a tin placed on a tray.

"On the sixth morning the tray and tin were given them in the usual way, but without any water. They ran to it, scooped at the bottom, and made all the motions of the beak as if drinking. They squatted in it, dipping their heads and waggling their tails as usual. For some ten minutes they continued to wash in non-existent water, the coolness of the tin to their breasts perhaps giving them some satisfaction."

However, the next day they soon gave up the attempt, and "on the third morning they waddled up to the dry tin and sadly departed" (p. 96).

The congenital nature of the movements in bathing were well shown by jays and magpies. One of the latter was observed by Mr. Charbonnier "to go through all the gestures of a bird bathing" upon the floor of the cage, after pecking once or twice at the surface of water in a pan with which it had been supplied for the first time.

Some of the main general conclusions will be found summarised in seven short paragraphs at the end of Chapter iv.

The succeeding chapter deals with the young mammal. The immense difference in the activity of the newly-born young of various mammalian groups is well brought out by numerous interesting examples.. Chief among the congenital associated movements of the young mammal is the act of sucking, in response to the contact of any solid substance of suitable size with the mouth. A more striking instance of the purely reflex and congenital nature of the performance, than any as yet recorded, was described to the present writer by Dr. J. Sidney Turner.

"There is no doubt whatever," Dr. Turner writes, "about the sucking reaction before birth (*i.e. before* the instinct can be in any way useful—indeed it would be the *reverse* of useful). During the process of cephalic version which is done whilst the fœtus is high up in the uterus, I have, on several occasions, placed my little finger in the mouth of the fœtus, and it has most distinctly sucked the finger exactly in the same manner as a born baby would do. . . . I don't know at what age of the embryo fœtus sucking is possible, but I know that a six months fœtus, at birth, can suck well."

It is satisfactory to be able, with Dr. Turner's permission, to put on record this interesting observation upon the human species, an observation which may well be added to the numerous others given in Chapter v.

The conclusions of Spalding and others that the kitten recognises and shows an instinctive fear of the smell of the dog are criticised, and the true inference is shown to be probably as in the case of the chick, the characteristic behaviour being only an example of congenital response to almost any strong stimulus. The responses in later life are explained as the results of experience and of parental influence. Prof. Lloyd Morgan freely admits that "there may be an instinctive basis, however, in some cases where animals are by nature enemies." The behaviour of the frog in presence of the grass-snake and of the rabbit in presence of the stoat would be especially interesting to investigate from this point of view.

It is well pointed out in this chapter that however much instincts are

"utilised, modified, and adapted through experience and acquisition, yet the fundamental distinction between that which is congenital and instinctive, on the one hand, and that which is acquired through individual experience, on the other hand, remains unaltered. . . . The instinctive action is prior to experience; the acquired action is due to experience. And this distinction holds, no matter how hard it may be to decide whether this action or that is in the main instinctive or in the main acquired."

These earlier chapters, which are full of interesting observation and acute criticism, have been drawn upon to a considerable extent in this notice; but all who are interested in the subject are bound to study the original. The limits of space prevent any further reference to the close reasoning in the important chapters which deal with the material supplied by these observations, and out of it construct for us valuable theories of animal psychology and the mode of the working of the higher parts of the nervous system in relation to instinct, intelligence, imitation, emotion, &c. It is sufficient to say that to most, probably to all, naturalists who are accustomed to reflect on such subjects the conclusions will commend themselves as those which are to be legitimately drawn from the facts.

In the interesting chapter on "Some Habits and Instincts of the Pairing Season," the author protests strongly against "the unnecessary supposition that the hen bird must possess a standard or ideal of æsthetic value, and that she selects that singer which comes nearest to her conception of what a songster should be." It may be conceded that the word "æsthetic" is an unfortunate one to use in this connection. On the other hand, the comparison between the chick which "selects the worm that excites the strongest impulse to pick it up

and eat it" and the hen which "selects that mate which by his song or otherwise excites in greatest degree the mating impulse," although doubtless perfectly true in itself, leaves unexplained and indeed unexpressed the fact that the song or plume which excites the mating impulse in the hen, is also in so high a proportion of cases most pleasing to man himself. And not only this, but in their past history, so far as it has been traced (*e.g.* in the development of the characteristic markings of the male peacock and argus pheasant), such features have gradually become more and more pleasing to us as they have acted as stronger and stronger stimuli to the hen. Why should this be?

In the chapter on nest-building, incubation and migration, there is a most effective reply to those (and they are many) who point to the "coincidence" that "congenital variation on the one hand, and intelligent choice on the other, coincide in direction and tend to the same result," as almost too much to be believed except on the supposition that the latter has through heredity given rise to the former. To this argument the author replies that both these principles are

"working, in their different spheres, towards the same end—that of adaptation. . . . Is it a coincidence in any proper sense of the term? Surely not. If two men start for the same place, the one by sea and the other by land, we should not regard it as a coincidence if both got there."

A number of interesting facts are quoted about bird migration, and the author surmises, but very cautiously, that

"while the migratory instinct is innate, and perhaps there is an instinctive tendency to start in a given direction, yet the element of traditional guidance may be effectual, in the migratory stream as a whole, in some way that we have hitherto been unable to observe" (p. 261).

The onus of proof seems certainly to rest with those who dispute this latter conclusion, and who hold so inherently improbable a view as that there is an instinctive knowledge, prior to experience, of geographical routes of enormous length and devious course. A single observation recorded by W. Warde Fowler (in the *Midland Naturalist*) a few years ago, points very strongly in the opposite direction. Mr. Fowler was standing on the English coast just opposite the western end of the Isle of Wight, but the day was misty and the island invisible. He watched the successive companies of swallows sweeping by eastward to join the migratory stream to the south, and he saw that each company followed the circuitous coast-line leading north of the island. All at once he noticed a change: a company arriving at the spot where he was standing, rose in the air and then flew to sea in an eastward direction. He then turned and saw that the mist had cleared and the island was visible. The birds were now able to take the shorter route, for they could see the way.

With regard to the question "Are acquired habits inherited?" the author in the thirteenth chapter, after a keen criticism of the evidence concludes, but with much caution, that "there is but little satisfactory and convincing evidence in favour of transmission." The appearances which have suggested an opposite conclusion to many writers are explained in the next chapter, "Modification and Variation." We have here an exposition of a most interesting and useful suggestion independently made by the author, Prof. Osborn of New York, and Prof. Mark Baldwin of Princeton. Others (*e.g.* Prof. Weismann) have previously laid more or less stress upon the same principle, but it has been due to the writings and influence of these three authorities that the matter has been put in its true light, and the principle shown to be an important contribution to organic evolution. This principle, which has been described in America by the not very self-evident term "organic selection," is thus explained by Prof. Lloyd Morgan in the work now referred to.

"If now it could be shown that, although on selectionist principles there is no transmission of modifications due to individual plasticity, yet these modifications afford the conditions under which variations of like nature are afforded an opportunity of occurring and of making themselves felt in race progress, a farther step would be taken towards a reconciliation of opposing views."

A case is then considered: suppose there is a change of environment and the congenital variations are not equal to the occasion, "individual plasticity steps in to save some members of the race from extinction . . . through a modification of the bodily tissues." In this way time is given for the appearance of congenital variations in the same direction, which is therefore rendered possible by the power of individual modification.

"Thus, if the conditions remain constant for many generations, congenital variation will gradually render hereditary the same strengthening of . . . structure that was provisionally attained by plastic modification. The effects are precisely the same as they would be if the modification in question were directly transmitted in a slight but cumulatively increasing degree; they are reached, however, in a manner which involves no such transmission." In this way "we may accept the facts adduced by the transmissionist, and at the same time interpret them as selectionist principles."

This principle is, in the opinion of the present writer, a valuable aid in the attempt to understand the evolution of the organic world. It should be observed, too, that the author does not intend any part of this principle as a substitute for natural selection; for he fully recognises that the "innate plasticity" is as much a product of natural selection as "congenital definiteness" (p. 319).

The last chapter deals with "Heredity in Man"; and here the author concludes that

"mental progress is mainly due, not to inherited increments of mental faculty, but to the handing on of the results of human achievement by a vast extension of that which we have seen to be a factor in animal life, namely tradition."

In his final summary he states that

"there is little or no evidence of individually acquired habits in man becoming instinctive through heredity. Natural selection becomes more and more subordinate in the social evolution of civilized mankind; and it would seem probable that with this waning of the influence of

natural selection there has been a diminution also of human faculty. Hence there is little or no evidence of the hereditary transmission of increments of faculty due to continued and persistent use. A discussion of heredity in man thus confirms the inference drawn from the study of habit and instinct in some of the lower animals."

Those who disagree with any of these conclusions are invited to study carefully the strong arguments by which they are supported.

Further discussion of many of the interesting questions raised in this valuable work would have been desirable, but the limits of space forbid. Enough has been said, however, to show that this book compels the serious attention of all who profess to feel an interest in the instincts and habits of animals.

The printing and general get-up of the volume leave nothing to be desired. There is one excellent plate forming the frontispiece, representing a group of the young birds employed in the recorded observations, drawn by G. E. Lodge. E. B. P.

TRAVELS IN INDO-CHINA.

From Tonkin to India by the Sources of the Irawadi. By Prince Henri d'Orléans. Translated by Hamley Bent, M.A. Illustrated by G. Vuillier. Pp. xii + 467. (London: Methuen, 1898.)

FROM the time of the great expedition under Doudart de Lagrée, which in 1866–68 threw such a flood of light on the countries watered by the great Mekong River, and of which the story was so admirably told by the lamented Francis Garnier, the exploration of the eastern half of Indo-China has fallen almost entirely to Frenchmen, who with untiring energy have traversed its jungles, and by their successful enterprise have added an empire to the dominions of the French Republic. But in spite of the labours of these devoted pioneers, and of the equally zealous explorers who, from the British side, have sought to disclose the mysteries of that long-closed region, there still remained an inner recess, as it were, to which no European had succeeded in penetrating. The region in question had for many reasons possessed a singular fascination for geographers. Traversed, to use the words of the late Sir H. Yule, by "that formidable fascis of great rivers, descending from the highlands of Tibet, which give to the map of this region an aspect so unique in geography," it engaged attention not only from the various problems connected with the courses of those rivers, but from the remarkable barrier which it placed in the way of communication between the neighbouring countries of India (Assam) and China, a barrier so effectual that the same high authority, writing in 1883, could adduce only three instances in which it had been pierced during our own times, even by a piece of intelligence. It was reserved for Prince Henri d'Orléans, who had already made himself known by several enterprising journeys, to be the first to cross this barrier, in company with MM. Roux and Briffaud, and his lately-published narrative may be said without hesitation to have fully deserved the honours of a translation, such as is now before us.

Prince Henri's journey naturally falls into three sections, the interest of which may be said to stand in an ascending ratio. In the first, a little-known region lying on the borders of Southern Yunnan and Tonkin was traversed from east to west, the route terminating at the interesting Chinese town of Sumao, famous as the centre of distribution of the so-called "Puerh" tea, grown in the Shan country to the south. The second, of which the direction was mainly from south to north, was concerned with the exploration of a section of the Mekong, for a knowledge of which we were previously dependent solely on old Chinese maps, with the one exception of the crossing-point of the road from Burma to Yunnan. The river was struck at a point somewhat to the north of Kiang (or Xieng) Hung,[1] reached from Maulmein by McLeod in 1836, and likewise the last point at which the river was seen by Lagrée and his companions. From here, with the exception of a detour to Tali-fu and a minor deviation into the neighbouring Salwen basin, the valley of the Mekong was followed as far as the French mission stations in South-eastern Tibet, through the countries of the Lamasjens, Lissus, and other wild and imperfectly known tribes. The third and last section, in which the westerly direction was resumed, led across the previously unpierced barrier between China and Assam, the region of the Irawadi head streams, the system of which had been previously the subject of so much controversy among geographers. The starting-point for this section was the mission station of Tseku, the furthest point reached by Mr. T. T. Cooper, when he, too, nearly thirty years ago, made his first daring attempt to traverse the same, then impenetrable barrier.

The country traversed by this route was of such a character as to try the mettle of the hardiest of explorers. The great rivers, as is well known, flow in parallel courses, separated by steep mountain ranges, up which the traveller must climb by the most difficult of paths, which often run sheer above the foaming torrent rushing many hundred feet below him. The Prince's party were provided with a caravan of mules, and even these sure-footed beasts would occasionally lose their footing and roll down the steep mountain-side. They seem also to have had a propensity to stray, which entailed many an arduous search.[2] No less arduous were the marches through the trackless, dripping forests of the Upper Irawadi basin. The crossing of the rivers, too, often involved serious difficulties. The Mekong is provided in places with iron chain-bridges, the vibration of which demanded a steady nerve in the crossing; but this was nothing to the actual danger involved by the passage of rushing streams on frail rafts or by slippery bamboo bridges, or those consisting, after the Tibetan fashion, of a mere rope, down which the passenger shoots with lightning rapidity. The trusty interpreter Joseph, a convert of the missionaries at Tali, who, with his non-

[1] Prince Henri is in error in saying that a railway is in course of construction to Kiang Hung from Mandalay. Although schemes have been set on foot for the reaching of this place by railway from Siam and Lower Burma, the railway from Mandalay is to make for the Kunlon ferry across the Salwen, and to reach the Chinese frontier through the state of Kokang, lately ceded to Great Britain.

[2] A strange kind of fodder, given to them by the drivers, on the recommendation of the Tibetans, was a hash of raw fowls and salt, said to be a rare pick-me-up for beasts of burden.

descript Latin (his only medium of communication with the travellers), supplies many humorous touches, "loved not water frolics," and would utter a fervent *Deo gratias* when the danger was safely past. This man proved a valued and faithful servant, and, sharing all the dangers and vicissitudes of the way, was finally regarded rather in the light of a friend than a dependent.

Apart from the surface forms, the vegetation offered much of interest to the explorers, and its varied aspects —from the tropical forests of the lower valleys, to the woods of superb coniferæ on the mountain slopes, and the alpine flowers of the higher passes—are brought vividly before us as we read the Prince's pages, which describe some charming scenes. We read, *e.g.*, of cool forests "where white dog-roses scaled the trees and drooped in fragrant clusters over dazzling diadems of lilies of the height of a man, and under foot pink primulas made a gay carpet." Much valuable information is given, too, with respect to the aboriginal tribes above alluded to, as well as the Lolos of the extreme south of Yunnan, of whose manuscripts a fair number were obtained. Several specimens of the hieroglyphic writing of the Mossos on the Tibetan border were also procured, and the meaning of some of them, hitherto obscure, was explained by the magicians by whom the books are made. The Mossos and the Lolos are said to have probably had the same origin, belonging to the Tibeto-Burmese family; the Lissus also speak a dialect resembling that of the Lolos. Among the Minchias and Lissus some individuals seemed to have little in common with the yellow race, and one Lissu woman reminded Prince Henri of Russian gipsies. Vocabularies of the languages of all these tribes are given in an appendix; but we do not find any comprehensive summary of their affinities, which would have been of much value.

A word must be devoted to the illustrations, with which the book is liberally provided. Their authority is not stated in the English edition, but from the French title-page we learn that they are from the author's photographs. It is doubtful, however, whether the artist has not in many cases allowed himself considerable freedom in their reproduction, especially in the somewhat sensational incidents represented. The translation is, on the whole, excellent; but a few errors of the French edition with regard to proper names have been retained. Thus we find Rochill for Rockhill, likewise Bonnin, Manhat, Néris, and Aymard, presumably for Bonin, Mouhot, Neis, and Aymara, which shows the need of revision by one acquainted with the subject treated. For English readers the French spelling of geographical names should have been modified. It requires an appreciable amount of time to recognise the pronunciation of some in their unfamiliar garb, as, *e.g.*, when In-shwan is written In-chouan. According to the prevailing French fashion the spelling Thibet is retained. This has, it is true, the authority of M. Desgodins, but others of his countrymen have held the *h* to be incorrect, or at least unnecessary. (Cf. *Comptes rendus*, Paris Geographical Society, 1887, *passim.*)

Taken as a whole, however, the book forms a worthy record of an important journey, and the interest of the narrative is well sustained from beginning to end.

INJURIOUS INSECTS DURING 1897.

Report of Observations of Injurious Insects and Common Farm Pests during the Year 1897, *&c.* By Eleanor A. Ormerod. Pp. viii + 160. (London: Simpkin, Marshall, and Co., Ltd., 1898.)

THE publication of this, the twenty-first of these annual reports, will prove, as heretofore, welcome both to agriculturists—for whom primarily they are intended—and to those interested in a public-spirited and isolated attempt to grapple seriously with problems of State entomology in this country.

Of insect attacks to field crops during 1897, no cases of the first importance are recorded; the Cabbage-aphis (*Aphis brassicæ*) and Silver Y-moth (*Plusia gamma*) were locally destructive, the latter to mangolds in Co. Kerry, and attack of the Diamond-back moth (*Plutella cruciferarum*) on turnips was again reported, this time from various spots on the east and west coasts of Scotland. As has so often been the case of late years, nematode disease of oats and clover was troublesome.

During the last few years the strawberry crop has suffered badly from two species of ground-beetles, *Harpalus ruficornis* and *Pterostichus vulgaris*, which have acquired the habit, singular in carnivorous insects, of feeding on the unripe and ripe fruit. The infestation has occurred in several counties, ranging from Nottinghamshire and Hertfordshire to Gloucestershire, and causes much loss and anxiety to growers. No satisfactory mode of prevention is known, and recourse is generally had to methods of trapping the imagos. Evidently, the breeding habits and mode of life in the larval stage should be more fully studied; the suggestion, sometimes made, that the insects are conveyed with manure, is somewhat improbable, and needs proof.

In 1889, much interest was aroused among entomologists by the attacks on plum-trees of a Scolytid beetle, *Xyleborus dispar*, previously a very rare species in Britain. Curiously enough, Miss Ormerod now records a severe infestation of the same orchards by a second species, *X. xylographus* (*saxeseni*). The subject is dealt with at length, but without fully establishing the culpability of *X. xylographus*, itself rather a scarce species in England, and one not usually associated with injury to healthy trees. *X. dispar* was also present in small numbers, and the coexistence of these species, so often found in association on the continent, may point to a possible importation. These attacks deserve further careful study; the relationship between Scolytid infestation and the health of the host-plant, however obscure, should never be disregarded or minimised, and the author's singular statement, that she knows of no difference between the perforations in trees made by each species, proves that their respective shares have not been properly evaluated.

Amongst other enemies to trees, *Cryptococcus fagi* has proved very injurious to beech at Burton-on-Trent. Common as it is, it is seldom so markedly destructive. Treatment is difficult, as insecticide dressings cannot always be profitably employed on trees of so large a size.

The report contains articles on several granary insects, including the Angoumois moth, *Sitotroga cerealella*, which

is probably often imported in grain, without establishing itself permanently in the country; and among subjects of minor importance, cockroaches, earwigs, and the like, may be noted the importation of dead locusts in some numbers in fodder from the Argentine Republic. There is evidence that their consumption has caused injury to horses, perhaps through mechanical irritation. Needless to say, Miss Ormerod does not encourage the idea that the introduction of live locusts, which in small numbers is almost an annual occurrence, is likely to cause an invasion.

It must, we imagine, be a source of regret to the author that the example she sets does not lead to a more thorough study of our insect pests. In many cases, the good that can be done by a referee, restricted as to opportunities for field observation, and depending largely on the capacity and good-will of correspondents, soon reaches a limit, which requires to be extended by broader methods of inquiry on the lines which have been so well developed in the United States. And it is satisfactory to note that the economic treatment of that very troublesome pest, the Currant Gallmite, discussed in a special appendix, is now being made the subject of extended research at the Woburn Experimental Fruit Farm.

W. F. H. B.

OUR BOOK SHELF.

Elements of Comparative Zoology. By J. S. Kingsley, S.D., Professor of Zoology in Tufts College. Pp. 344, small 8vo.; with 148 illustrations. (New York: H. Holt and Co., 1897.)

THE reputation of the author of this little book justifies the expectation of novelty, and in this we are not disappointed. The work, which has a local flavour, is based upon a conviction expressed in the preface, that while "laboratory guides are somewhat numerous . . . general outlines of zoology adapted to beginners are few," and that "nature studies are truly educational only when the student is trained to correlate and classify facts." Imparting a knowledge of the zoological alphabet by the now universally adopted Huxleyian method, the author proceeds to supplement that by a sort of reading lesson, in the form of a very brief outline of some of the chief structural limitations and ordinal characters of each group of which a typical species has been previously more fully examined, leading thus up to class distinction and the definition of phyla. In this manner the gnathostomatous vertebrata are first taken in hand in ascending order, and next the invertebrata in descending; and after a short chapter on each of the great animal sub-kingdoms, the work concludes with others on the metazoa, protozoa, comparative physiology, morphology, and on the animal kingdom. The practical mode of elementary instruction in biology by the type-system was never intended to go unsupplemented; and while the plan here adopted is one which must have been elsewhere in vogue, as the natural result of the growth of the system, to the author is due the credit of having first developed it in print. His chief novelty lies in the substitution of an interrogatory for the time-honoured didactic mode of treatment of the practical portion of the subject, with the introduction of a series of "Comparisons" in the form of questions which make for correlation of ideas. A very ingenious departure! but we would rather await the verdict of time upon it than pronounce outright. Fair consideration is given to habit, distribution, and other topics where desirable; and the book, though thin, is on the whole trustworthy and fairly up to date, its weakest part being the physiological, the few short pages devoted to which are hackneyed and behind the times. A goodly amount of sound advice is scattered throughout the introduction and the text. The illustrations are very unequal, Fig. 63 being a positive burlesque on nature, Fig. 25 antiquated and useless, and Fig. 69 erroneous, by lack of knowledge of the large series of observations finding their focus in Boas's discovery of a prepulmonary aortic arch in the frog's tadpole. As leading error may be cited the allegation concerning the function of the marsupial bones, and as ill-advised the adoption of the Hæckelian classification of birds. In formulating so common-place a system as the dental of the dogs, the author has gone astray; and special interest attaches to the remark that he, an American, should write of the Ruminantia Cavicornia that their "horns are never shed," and give, in illustration of this assertion, a picture of the American Prongbuck, notorious as the only exception to that rule! We would recommend the consideration to the zoological brotherhood.

The Tutorial Chemistry. Part ii. *Metals.* By G. H. Bailey. Pp. 300. (London: W. B. Clive, 1897.)

THE present volume is intended to supply the student with his second year's course of study, the first year having presumably been spent over the "non-metals." The first section, occupying about one-third of the book, deals with chemical physics, the remainder being taken up with the systematic description of the commoner metals. There are three appendices, dealing with crystallography, spectrum analysis, and some suggested experiments. The section on chemical physics commences with a description of the methods available for the determination of atomic weights, this being followed by a discussion of the relations existing between the numbers thus found and the physical properties of the elements. Chapters iv. and v. deal with dissociation, specific volume, and the optical properties of liquids. The chapter on solution is the largest in the section; but the treatment of this important branch of the subject is not so satisfactory as that of the other portions dealing with physical chemistry. Thus, while a considerable amount of space is devoted to the hypothesis of Grotthus, which the student will afterwards have to unlearn, the work of Hittorf is not mentioned, although the latter forms the keystone of the modern theory of solution.

In spite of the great compression necessary, only 150 pages being allotted to a description of some fifty elements, the latter portion of the book gives a clear and concise account of the preparation and properties of the metals, each group being preceded by a summary of the reactions common to its constituents.

The classification of Mendeléeff is adopted throughout; and since the clear exposition of the periodic law requires the inclusion of certain of the "rare" metals, such elements as gallium, indium, thallium and uranium are described in their proper places along with commoner elements, instead of being relegated to a kind of museum of curiosities in the form of an appendix—a practice unfortunately usual with the smaller text-books.

The Kingdom of the Yellow Robe: being Sketches of the Domestic and Religious Rites and Ceremonies of the Siamese. By Ernest Young; with illustrations by E. A. Norbury. Demy 8vo. Pp. xiv + 399. (Westminster: Archibald Constable and Co., 1898.)

THE author has had the advantage of several years' residence in Siam, during which time he learned the language, and his educational duties enabled him to observe the working of the native mind. He writes with an evident sympathy for the common people; and in his sketches of the every-day life of the capital, he has caught not a little of the humour which is one of its chief characteristics. He discourses pleasantly on

street and canal scenes, and explains at some length many of the more important ceremonies by means of which Siamese Buddhists make the amount of "merit" necessary for the bettering of their position hereafter, and he gives a short account of the Buddhism of the country. The author makes some interesting observations on education, and gives an attractive picture of the children with whom his duties brought him in contact. He does not go far beyond the capital, and the scattered remarks about the interior do not enlighten the reader much as to the commercial aspects of the country. Politics have also been rigorously excluded. On the whole there is not much which may not be found in Turpin, Crawfurd, Bowring, or Alabaster, or in the recent writings of Captain Gerini. The author does not, however, pretend to an entirely original or exhaustive treatment of the subject. His aim has rather been a chatty and popular account of the life and ideas of the ordinary people, as they present themselves to the observant resident of Bangkok. The Far East is daily coming nearer, and becoming more intelligible, to the Western reader, and the present work is one which, in our opinion, distinctly helps to bridge the gulf which yet lies between them.

The illustrations, which, it is no discredit to the author to say, form the chief feature of the book, are by Mr. Norbury, another old Bangkok resident. Some of these, especially the full-page drawings towards the end of the book, are quite charming, and give some characteristic scenes with a rare combination of fidelity and artistic effect.

The West Australian Settler's Guide and Farmer's Handbook. (Perth, W.A.: Wigg and Son, 1897–98.)

West Australia is at the present time best known to us by its gold mines; the real importance of this vast and almost unoccupied territory must, however, be determined by its capability of supporting in the future a large population, and hence the agricultural capabilities of the country become an extremely important factor in any schemes for its development. The Handbook before us is issued by the Agricultural Department of the Colony; its object is to present a picture of the agricultural capabilities of various districts, and to advise intending settlers as to their best course of action. It deals chiefly with the south-western portion of the Colony, a district enjoying a better and more uniform rainfall than is generally met with in Australia, and the general fertility of which is vouched for by the occurrence of large areas of heavily-timbered land. The forests of West Australia are said to occupy more than forty million acres; the wood from them has already been employed in paving London streets. Large areas of the country appear to be especially adapted for vine culture. Part i. of the Handbook describes the agricultural areas open for selection. Part ii. contains general instructions for settlers. Part iii. deals with the natural grasses and weeds, and with various imported crops. Part iv. is devoted to sheep husbandry. Part v. is a general treatise on soils and manures, without much special reference to Australia. The whole publication is freely illustrated. The photographs of the forest trees are very striking. The maps are bad, and quite insufficient for the purpose. The Handbook has evidently been hastily put together, and its value is often marred by the want of a clear arrangement of the subjects discussed. R. W.

Die Gattung Cyclamen *L. eine systematische und biologische Monographie.* By Dr. F. Hildebrand. Pp. 190, with 6 plates. (Jena: Gustav Fischer, 1898.)

Living plants have served Dr. Hildebrand as the basis of his careful study of the genus *Cyclamen*, and herbaria have afforded additional material. The result is a most thorough monograph of the genus, the thirteen species of which have been studied in great minuteness. Eighty pages are given to the description of these, and the remaining portion to a general review of the genus. The book is extraordinarily free from theory; indeed, it is a storehouse of facts.

One species of this genus, *C. persicum*, has recently been brought forward as affording a good instance of the gradual accumulation of small variations, which has yielded the many forms in cultivation. For this reason it has a special interest; and Dr. Hildebrand's assertion of the variability of the wild plants (p. 166), and his recognition of no hybridisation of this species, come as opportune remarks. Variation in the leaf has particularly attracted the author's attention; and he notices, too, that there can be traced no connection (p. 172) between the variability of the foliar and floral organs.

Of biological interest are such statements as the following: that the corms have for a protection some poisonous substance (p. 92); that the leaves have no character in them which will definitely support Stahl's theory of the relation of their shape to rainfall (p. 110); that the pollen, at first sticky, becomes dry and powdery (p. 132); that ants appear to aid in the dispersal of the seeds (p. 142); and that the corm begins to form very early in germination (p. 11). From these the general trend of the book may be judged; but, in addition, anatomy, teratology, distribution, and the relation of the species to their habitat, the rest of the seed, age of the plant at flowering, colour of the leaves, &c., find a place. The whole results in a most careful work, which, unfortunately, wants a good index. I. H. B.

An Arithmetic for Schools. By S. L. Loney, M.A. (London: Macmillan and Co., Ltd., 1898.)

This is a comprehensive text-book clearly written and well arranged. There is a useful chapter on abridged methods and approximations, and a note (in the appendix) on the metric system. Compound interest is, very properly, done entirely by decimals. The examples are numerous, sensibly chosen, and carefully graduated. The term "concrete number" is objectionable; so is the statement "1 lb. of sugar = 2*d.*" in the explanation of the chain rule. In compound proportion too much of the old-fashioned paraphernalia has been retained; and we think that too much attention has been paid to the conversion of vulgar fractions into recurring decimals, and *vice versâ.* It would be a good thing if recurring decimals could be eliminated from all elementary examinations in arithmetic; they are of no practical use, and the tiresome calculations connected with them help to perpetuate the English prejudice against the metric system. It may be worth noticing that in Chapter v. the term "power" and the index notation are apparently introduced without previous explanation. In some cases it would be well to give not only an explanatory working of an example, but also the actual computation, arranged in proper form. It is true that this is done in many cases; but there are many others where the working is decidedly clumsy, owing to the addition of explanatory matter. On the whole it may be said that this work, while not specially distinguished by novelty of treatment, deserves to rank with the best of its class. G. B. M.

Navigazione Aerea. By Guglielmo N. Da Pra. Pp. 73, with 18 woodcuts and 6 plates. (Milan: Ulrico Hoepli, 1898.)

This is a critical examination of the various conditions which must be satisfied by a flying machine, together with designs of proposed arrangements of aeroplanes to be worked by means of benzene motors symmetrically arranged.

On the principle that "an ounce of practice is worth a pound of theory," it will be interesting to see how far Signor Da Pra's predictions as to the form of the flying machine of the future are confirmed by future experiments. G. H. B.

Lessons with Plants. By L. H. Bailey. Pp. xxxi + 491. (London: Macmillan and Co., Ltd., 1898.)

THOUGH written for the use of teachers and students of botany in North America, this book will be found almost as useful on this side of the Atlantic. Very many of the plants employed as examples are either natives of, or very generally cultivated in, the British Islands, and could easily be obtained both in country and in town. Even where the selected examples are not themselves readily procured among us the methods of study, the lessons drawn from them, and the suggestions offered for further personal investigation, are very often such as could be readily applied by an intelligent reader to British species.

The author very consistently carries out his method of instruction. He assumes that the pupil is absolutely ignorant; and taking familiar objects, such as an apple-twig, he shows simply and well the information that can be read in them by the trained eye and mind. The book is admirably fitted to give training in the methods of observation, in so far as that can be given during school-life. It should be of peculiar value to teachers if used (as the author, in the introduction, points out that it is meant to be) to suggest how lessons can be drawn from any and every plant. One cannot read many pages without realising that the careful observation and accurate knowledge gained by the teacher that works out examples in the manner followed here will enable him to make the subjects taught by him very real and living. It is the true scientific method applied to the first steps in botany. To the beginner in the science, also, who wishes to learn, but cannot obtain systematic instruction, this book would be an excellent introduction. If each section were read with the actual specimens in hand, and compared with the description step by step, and, still more, if the "suggestions" were followed out practically, the student would have gained a very valuable training, and a trustworthy foundation on which to build up the wider study. The method followed is naturally somewhat informal; but it allows of many sides and applications of botany being touched on in a way to awaken the interest of pupils; and the information conveyed is of a kind that does not require to be unlearned, but can be built up into its proper place as the study becomes more systematic. Occasionally one feels that the explanation is insufficient, and that it must leave a vagueness in the mind of a beginner, as, for example, where we are told that it is "the custom of botanists" to "say that when either floral envelope is wanting it is the corolla (unless there is some special reason to the contrary). This is, generally, an arbitrary definition, but it would be just as arbitrary to say that the sepals are missing." It is scarcely "evident" in respect of the ligulate flowers of the dandelion and Rudbeckia "that if the corolla of a floret were to develop to such a length, it could not spread equally in all directions, as a mathematical calculation will prove; it therefore develops in one direction, as a leaf does." The description of the flowering spurge would scarcely be clear to a beginner. But such defects are so inconspicuous as to detract little from the value of the book, which is enhanced by many excellent original "delineations from nature."

Ethnological Studies among the North-West Central Queensland Aborigines. By Walter E. Roth. Pp. xvi + 199, and Plates. (Brisbane: Gregory, 1897.)

THE chief difficulty which an investigator has to surmount in studying the habits and customs of a savage race is their innate suspicion, which often prevents them relating not only the traditions of their tribe, but also their common customs.

Roth claims to have overcome this difficulty by a prolonged residence among the natives of North-West Central Queensland, and states that it was not until he was fully conversant with their language that he could acquire sufficient confidence from the natives to learn their customs.

As an aid to future explorers, he begins his book with an elementary grammar and vocabulary of the language spoken in the Boulia district: a table is added, comparing the words in common use in adjacent districts.

This race communicates ideas by signs as well as sounds; the origin of the actual manual movements is usually easy to trace, and lucidity is added to the description by illustrations. Social and individual nomenclature among these races is developed to such an extent, that careful study of an admirable chapter devoted to the question is necessary for the reader to fully comprehend that intricate organisation.

Roth describes the food and the method of obtaining and preparing it; the recreations and amusements of the people. Cannibalism, he states, is practised in the Boulia district; but a person is never slain for the purpose of supplying food, nor may any but relatives partake of a corpse.

The last chapter is devoted to descriptions of initiation ceremonies, which are often too gruesome to dwell upon in detail. The book consists of a description of a number of facts; the origin and development of customs is but rarely attempted.

L'Électro-chimie. Production électrolytique des Composés chimique. By A. Minet. Pp. 167. (Paris: Gauthier-Villars et Fils; Masson & Cie.)

THIS little work is a volume of the well-known "Encyclopédie Scientifique des Aide-Memoire," and is devoted mainly to the industrial applications of electrolysis other than those of which the object is the preparation of metals. The chapter dealing with the electrolysis of solutions of sodium and potassium chlorides, which gives a good account of the more important processes which have been proposed for the preparation of caustic alkalis, hypochlorites and chlorates, may be specially commended. The attempts which have been made to employ electrolysis in purifying and ageing alcoholic liquids, in tanning, and in purifying sugar, are described, as well as a number of minor applications of the electric current.

"Théories de L'Électrolyse" (pp. 175) is another volume of the same series as the above, and by the same author. It gives a sketch of the theory of the voltaic cell, of the constitution of electrolytes and gases, and of osmotic pressure. Electrolytic conductivity and the migration of the ions are also treated at some length. The researches of the author's fellow countrymen are rather fully, though not always clearly, described, the work done in other countries receiving very inadequate treatment.

LETTER TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Malformed Crabs.

IN your issue of March 10 I observe a most interesting letter from your correspondent, Mr. R. I. Pocock, regarding a malformed specimen of *Cancer pagurus* in the Dover Museum. I have never seen such a remarkable case of malformation in the common edible crab, but in the Robertson Museum here is to be seen a very fine specimen of *Nephrops norvegicus*, having three digits on the right pincer or great claw. The supernumerary digit,

which is fully two-thirds the size of the normal one, springs from the inner side of the base of the inner movable finger, and is sharply toothed on both sides, and directly opposable to the outer finger. The normal digit is fully developed and curves outwards from the supernumerary one at a wide angle, the distance between them being fully three-quarters of an inch at the points. They move together, and permit an opening of about half an inch between the supernumerary and the normal outer digit, so that little or no inconvenience would be caused to the animal during life. This specimen was caught by fishermen in the neighbourhood of Cumbrae, and was given to a Millport gentleman, Mr. Liddle, who kindly handed it over to the Museum.

ALEXANDER GRAY.

Millport Marine Biological Station, March 6.

SCIENTIFIC EXPERTS AND PATENT CASES.

WE have often had occasion to point out the many disadvantages which are connected with the present system of obtaining and using scientific evidence in courts of law. The disadvantage which chiefly concerns us is that science and men of science are at times thereby drawn into and through mud of a most objectionable quality; but there are many others.

We are glad to see that the matter has again been brought to the front, and this time by the Lord Chancellor himself, and that alterations in the present mode of procedure are being discussed.

We content ourselves this week by reproducing the following leading article in Wednesday's *Times*:—

In the recent sittings of the Law Courts nothing has been more remarkable than the large number of patent actions. Certain inventions have been veritable gold mines to patent lawyers, agents and experts. The bicycle is scarcely more familiar in the streets and highways than in the Courts. We could name patentees who are never out of litigation to protect their menaced rights; certain lamps, gas burners, and explosives are always "going to the Lords." A very substantial part of judicial time is taken up in examining the rival claims of inventors, and they are likely to ask for more. The history of science is constantly illustrating the fact that the same ideas are in many minds at the same time, that often it is an accident whether A or B first propounds his suggestions, and that the priority of one over the other may be a matter of a few months or even days. That is a partial explanation of the multitude of disputes as to bicycle tires, bicycle saddles, metal rims, chains, and gear of all sorts. A further explanation is to be found in the profits derivable from patents as to articles used by hundreds of thousands. Sometimes the Courts are called upon to decide between two independent inventors. Just as often the fight is between one who has an honest claim and another who wishes to levy blackmail or to be bought out. The mode of determining such actions is far from satisfactory. The Lord Chancellor, in a case in the House of Lords which we reported the other day, gave expression to a widespread opinion on this point. The case turned on five or six lines in a specification relating to the tires of bicycles; but it occupied inordinate time both in the Court below and in the Court of Appeal. "Having regard to the extravagant and extraordinary consumption of time which was involved in the determination of this case," said the Lord Chancellor, "witnesses of great eminence being called upon both sides and evidence given which amounts in the book which I hold in my hand to 500 printed quarto pages, it is no wonder that, if a case so simple in its character is so protracted, there is what is called a 'block' in the Courts of law." So serious is the state of things that the Lord Chancellor intimated that it might be necessary to hand over to a special tribunal the trial of cases for which the ordinary procedure seemed inapt. A well-informed correspondent, Mr. W. L. Wise, in a letter which we publish to-day, expresses much the same opinion in even stronger terms. "The present state of things virtually amounts to a denial of justice to all but those having the command of large sums of money." This is an old complaint. Years ago the late Master of the Rolls said, "There is something catching in patent cases, which is that it makes everybody argue and ask questions to an interminable extent. A patent case, with no more difficult question to try than any other case, instead of lasting six hours, is invariably made to last six days, if not twelve. I am sure there ought to be some remedy for it." In Ehrlich *v.* Ihlee" the Court of Appeal took occasion to complain of the "frightful mischief" caused by the prolixity of the proceedings in patent actions. Mr. Wise suggests a remedy. He points out that the Comptroller-General of Patents or his deputy determines questions not unlike the questions of infringement which come before the Courts; and he trusts that, if the staff of the Patent Office were strengthened, a tribunal more economical, expeditious, and not less fit than the present would be found. An appeal lies to the law officers; and it is a recommendation to the suggested system, in the eyes of our correspondent, that at all stages patent agents may appear for the parties.

We have our doubts about the efficacy or success of this recommendation, though certainly not on the ground that patent agents, whom the Legislature has very properly recognised, would have a larger field than is now theirs. We should be glad to see them invested with more privileges, and corresponding responsibilities when they proved ignorant and careless. But such a tribunal would not satisfy patentees, who are the most pugnacious and persevering of litigants. Beaten in one Court, they will resort to another; if they at last acquiesce in the decision of the House of Lords, it is only because there is no tribunal above it. Such are the uncertainties necessarily attending many of the disputes, and, above all, such are the rewards that come with success in patent actions, that every weapon is, and always will be, used in the fight. It is not to be expected that, to take two examples at random, the parties to the litigation before Mr. Justice Wills in 1896 and 1897 in "The Incandescent Gas Light Company *v.* the De Mare Incandescent Gas Light System" and "The Pneumatic Tyre Company *v.* the Ixion Pneumatic Tyre Company" would be content with the decision of a few officials of the Patent Office. In the great majority of the cases referred to by the Lord Chancellor and by our correspondent much money is at stake; and the parties will spare no expense to gain their point.

A more plausible suggestion is that the evidence should not be left, as it now is, solely to the discretion of the parties; that the Judge should nominate some experts—if possible one in whom all have confidence—to report on the invention and the question of novelty, validity, or infringement; and that he should be guided by the report unless it was shown to be erroneous. This would prevent the competition, so common and so ruinous to poor litigants, in the production of expert evidence. It is no small recommendation of this suggestion that under other systems of law it is adopted and is found to answer. There is, however, some force in one criticism—Where, in many cases, is a truly impartial expert to be found? If the question is one of great importance, a scientific witness of eminence has probably in his writings or in some discussion committed himself, directly or indirectly, to an opinion on one or more of the points involved. To take an actual instance, it would have been difficult in the recent litigation between the Maxim-Nordenfelt Company and Sir William Anderson to have found a chemist whose report on the properties of the explosives under consideration would have been accepted as *prima facie* valid. Good might come of a special tribunal framed on the lines of the Commercial Court. But sometimes what is imperatively needed is the unbiased opinion of an intelligent outsider with no theories about physics. One point of delicacy is rarely touched by the critics of the existing system. It must be present to them all. In some professions a traditional sense of honour prevails to which all must conform, or appear to do so, and which prevents open and flagrant deviations from rectitude. Among doctors, for example, there are black sheep; but they keep well out of sight. It is notorious that, even in cases in which life and death are at stake, or when there happens to be a temptation to speak loosely, it is rare to find a doctor giving evidence in favour of theories which his brethren would scout as manifestly absurd. Could as much be said of the testimony of scientific experts in patent actions? There may be countries in which such witnesses never overstate the case and never sell their opinion. Ours is not one of them. Many scientific witnesses who ought to know better have acquired a very bad habit; they have come to regard themselves as advocates—in the witness-box. It seems a poor palliation of a real evil to press on scientific experts—some do not need that counsel—a loftier notion of their function than befogging the Judge or finding more or less plausible reasons for what they know to be untenable and absurd.

PHOTOGRAPHIC SURVEYING.

FIFTY years ago or more, M. Beautemps Beaupré successfully employed a process which greatly facilitated the work of surveying, and which in its modern developments is likely to supersede the tedious work of measurement in the field. Where the greatest accuracy was not required, the method recommended itself on account of its great practical utility, enabling contoured maps to be produced without the labour of heavy calculations. M. Beaupré availed himself of the principle of the camera lucida, and by its aid sketched the panorama about him from two ends of a measured base line. In a paper recently communicated by Prof. E. J. Mills to the Institution of Engineers and Shipbuilders in Scotland, it is contended that the best work is still done when this principle is utilised. From two views taken at a known distance from each other, however procured, one is able to plot a map with a fair amount of accuracy, and knowing the correct relative distances of the objects their vertical height can be deduced. No doubt there were difficulties in the application of the method. Any one who has attempted to draw a picture of a distant object by means of Wollaston's invention knows that the result is apt to be a little disappointing, though successive improvements in the mechanism have removed many of the effects arising from parallax, which interfered with correct delineation in the early days when the instrument was first used. But the process still remains long and tedious, and it was inevitable that the introduction of photography with its rapid and accurate results, should be welcomed as likely to banish the slow methods of hand drawing in the initial stages of the work.

To obtain a photograph which should be free from optical distortion, and to which the laws of geometrical perspective could be applied without any correction, has not been an easy task. But now it may be said that we do possess lenses which will cover an angular field of about 60° without measurable distortion, and give uniform definition all over the plate. Enlargements and printing from the original negatives doubtless still present some difficulties. Prof. Mills, we notice, recommends that the prints should be made on bromide paper, and developed with amidol. Shrinkage and distortion of the paper will, it is asserted, be prevented, when soaked in a two per cent. solution of formalin, and dried at a gentle heat. Other authorities, however, distrust paper altogether, and prefer to use a bromide emulsion on opaque or translucent plates of flat glass as likely to give less error. But the possession of accurate optical arrangements, combined with exact manuipulation of the photographic result, suggests many new applications to which the camera can be profitably applied, and the surveyor now finds himself equipped with an instrument of scientific precision, in which are combined the main features of a theodolite and a level, and which replaces the plane table and its accessories.

In the earliest form of surveying camera or photogrammeter, to give it a polysyllabic title, the instrument consisted of little more than an ordinary bellows camera, set on a horizontal circle, and moving about a vertical axis. The distance between the plate and the lens was fixed, and the camera could be levelled by means of screws in the head of a tripod in much the same way that a theodolite is adjusted. In the subsequent development and increased effectiveness that have been added to this surveying instrument, two names stand out prominently, that of Colonel Laussedat, the present Directeur of the Conservatoire des Arts et Metiers, Paris; and in this country that of Mr. Bridges Lee. In the French form, the camera is placed on the top of a stand carrying a transit theodolite, and the disposition of the several parts is arranged to ensure stability and symmetry about a vertical axis, while each part of the instrument can be used separately. In the English form, Mr. Bridges Lee has wisely determined that while each photograph should offer a correct perspective view of the country it represents, it should also carry on its face the information necessary for the correct interpretation of the picture, and the subsequent construction of a map. When passing through countries where roads are scarce and travelling difficult, notebooks are apt to be lost; but without more words, every one must appreciate the arrangement by which the "constants of reduction" are made as permanent as the picture to which they refer.

The general principles on which the Bridges Lee camera has been constructed, and the objects sought to be attained, have already been briefly explained in these columns (vol. li. p. 191). Its present form has been adopted because experiment has proved the necessity of great nicety of mechanical adjustment to obtain the best results. To ensure the necessary lightness and rigidity, the camera box is made of aluminium. The direction in which the instrument is pointed can be read off an azimuthal circle, graduated to minutes, on which the camera turns. A level on the top of the box ensures the horizontality of the instrument, and when this adjustment has been made, a telescope, also securely attached to the top of the camera, will move in a vertical plane through a sufficient range of angle for all ordinary terrestrial work. The angle through which the telescope can be moved in altitude is also read to minutes. This supplies the observer with a theodolite, and its position is so arranged with reference to the other parts of the instrument, that the line of collimation and the vertical wire of the theodolite are in the same plane with that which bisects the photographic lens. In this same vertical plane, a "wire" is fixed to the frame of the camera, cutting the optic axis of the lens at right angles, and consequently marks on the photograph the median vertical plane of the instrument. Another wire, also through the optic axis at right angles to this, will mark the horizon of the instrument on the picture, and the intersection of the two wires will give the "principal point" of the perspective. Inside the camera is placed a magnetic compass, and the scale being transparent, it is printed on the picture. The axis of rotation of this compass is in the same plane as the axis of collimation of the theodolite, and of the vertical wire. The distance between the scale of the compass and the vertical wire is kept constant by a device which works automatically when the camera is in use, and since this distance very slightly exceeds the radius of the compass, the wire can be used as a pointer to read the scale. One very important addition to the usefulness of the instrument is the insertion of a scale of angular distance, photographically prepared by the same lens as that fitted in the instrument when complete for surveying purposes. The scale is so attached to the frame, that it is photographed on every picture taken, and by its aid one can easily read off the angular distances of any point in the picture right or left of the median vertical plane.

A method of surveying in which the necessary observations are easily and rapidly collected, or are implicitly contained in a series of photographic views, has the promise of a large future. In travelling over unsettled districts, where it is impossible to remain for any length of time on a particular spot, the photographic method seems likely to supersede all others. Indeed no other method seems possible. Moreover, a photograph contains an amount of detailed information concerning the country photographed, which it is quite impossible to gather from notes of observations and sketches, although much time may be spent in making these additions as carefully as possible. In this connection, one might call attention to the beautiful mountain maps which have been prepared for the German and Austrian Alpine Club

Here the work is based on the original ordnance survey maps, and the topographical details filled in from photography. These maps represent one of the most successful applications of photographic surveying. Again, in preliminary experimental surveys for irrigation purposes, or for deciding on the best route for a proposed railway, the camera, properly controlled, possesses many advantages over ordinary surveying instruments. In such cases it is often excessively difficult to determine beforehand how much plotting will be necessary to secure the object in view. The district may have to be re-visited over and over again to supply the requisite details, all of which may prove useless in the end. But with the photographic pictures secured by a camera, the plan may be plotted so far only as required, and if additional information be needed, the photographs can be made to give all the detail wanted without going again to the field. Irrigation surveys for agricultural purposes have been effected in the North-West Provinces with complete success by the photographic method, and are likely to be still further extended. Prof. Mills tried to apply the method to the determination of the content of a ship in dock by constructing a model of the vessel in clay, the necessary dimensions for which were to be taken from measured photographs. When the amount of clay in the model, and the scale of the photograph from which the necessary measurements have been taken are both known, the capacity of the ship is at once determined. In this particular instance, it is true, the method failed, owing to the impossibility of selecting suitable stations for the photographs amid the crowded machinery of a busy ship-building yard. But the attempt shows the wide applicability of the method and the extent of the field open to the intelligent use of photographic appliances.

But its greatest triumphs are, of course, to be seen when the method is continuously applied over a large area. One of the most successful operators is Mr. E. Deville, the Surveyor General of Dominion Lands, who has carried his investigations over the difficult passes of the Rocky Mountains, and surveyed the country up to the United States boundary of the Alaska territory. No less than 14,000 square miles of this inhospitable country were surveyed in the years 1893–94. The proper administration of the country, he tells us, required a tolerably accurate map, and means had to be found to execute it rapidly, and at a moderate cost. The ordinary methods of topographical surveying were too slow and expensive for the purpose; rapid surveys, based on triangulations, and sketches were tried and proved ineffectual; then photography was resorted to, with the result just mentioned. The same authority, as was natural to one in his official position, has made a very careful comparison of the relative expense of a survey made with the plane table and one with the camera: all such comparisons are liable to be modified by the climatic conditions of the country, and the amount of detailed plotting required. In the climate of the Rocky Mountains, Mr. Deville estimates that on one half of the number of days in a season, no work can be done with a camera, owing to smoke, fog, rain and snow storms. But quite as great a loss of time is experienced with the plane table, added to which the apparatus is more weighty, requiring more porterage, and therefore additional expense in removal. But neglecting these and some other slight advantages which are on the side of photography, he finds that the plane table survey is three times (rigorously as 164 : 56) more expensive than that accomplished by the camera. This is a real practical advantage which is immediately appreciated, and on several grounds, not taken into Mr. Deville's estimate, such as the possibility of reducing the number of highly-trained assistants, it would seem that the difference of expenditure has not been over-estimated. There is no sacrifice of accuracy to secure this economy; the great improvement consists in the substitution of the methods of photography—methods, which proving highly popular, must tend to displace more and more the use of the plane table.

BALNIBARBIAN GLUMTRAP RHYME.

(Repeated by the children in the nurseries of Balnibarbi.)[1]

DISTANT scintillating star,
Shall I tell you what you are?
Nay, for I can merely know
What you were some years ago.

For, the rays that reach me here
May have left your photosphere
Ere the fight of Waterloo—
Ere the pterodactyl flew!

Many stars have passed away
Since your æther-shaking ray
On its lengthy journey sped—
So that you, perhaps, are dead!

Smashed in some tremendous war
With another mighty star—
You and all your planets just
Scattered into cosmic dust!

Strange, if you have vanished quite,
That we still behold your light,
Playing for so long a time
Some celestial pantomime!

But, supposing all is well,
What you're made of, can I tell?
Yes, 'twill be an easy task
If my spectroscope I ask.

There—your spectrum now is spread
Down from ultra-blue to red,
Crossed by dark metallic lines,
Of your cooler layer the signs.

Hence among the starry spheres
You've arrived at middle years—
You are fairly old and ripe,
Of our solid solar type.

Ah, your sodium line is seen
Strongly shifted towards the green.
Hence you are approaching me
With a huge velocity!

But, if some celestial woe
Overtook you long ago,
And to swift destruction hurled
Life on every living world,

Did there in the fiery tide
Perish much of pomp and pride—
Many emperors and kings,
Going to do awful things?

Mighty schemes of mighty czars—
Mighty armies, glorious wars!
From the Nebula they may
Rise to curse a world some day!

G. M. Minchin.

[1] Balnibarbi is one of the countries visited by Gulliver; the "Glumtrap" is the Balnibarbian equivalent of the English nursery; and the babies of Balnibarbi are brought up on strictly scientific principles—as is evidenced by their knowledge in these verses.

NOTES.

THE preliminary circular for the jubilee meeting of the American Association for the Advancement of Science to be held at Boston, August 22–27, has just been issued. Prof. Frederick W. Putnam, the president-elect, repeats the assurance given to the nominating committee at the last meeting, that this second Boston meeting, held on the fiftieth anniversary of the foundation of the Association, "gives promise of being the most important scientific gathering ever held in the United States." A special effort will be made to increase the membership, in the hope that at least one thousand new members will be added. The meetings will be held at the rooms of the Massachusetts Institute of Technology, and of the Boston Society of Natural History, occupying three closely adjoining buildings. The Association will be for one day a guest of Harvard University, and for another of the Essex Institute of Salem; the latter being the place of the museum of the Association, and its permanent office. A larger number than usual of the affiliated societies will meet in connection with the Association, including the American Forestry Association, the American Geological Society, the American Chemical Society, the Society of Economic Entomologists, the Society for the Promotion of Engineering Education, the Society for the Promotion of Agricultural Science, the American Mathematical Society, and several more. After the meeting excursions will be made to the White Mountains and to Cape Cod. The local committee has been fully organised under the honorary presidency of Governor Roger Wolcott. The honorary vice-presidents include the presidents of fourteen colleges and universities, besides many other prominent gentlemen. The local secretary is Prof. H. W. Tyler, of the Massachusetts Institute of Technology, 491 Boylston Street, Boston; and the general committee is a large and representative one, composed of the foremost citizens. The chairmen of the other committees are: Finance, the honorary treasurer, Colonel Henry L. Higginson; Reception, Dr. J. R. Chadwick; Rooms for meeting, Prof. Charles R. Cross; Invitations to foreign guests, Dr. Henry P. Bowditch; Excursions, General Francis H. Appleton; Cambridge committee, Prof. Charles W. Eliot, of Harvard University; Salem committee, Hon. Robert S. Rantoul, president of the Essex Institute; Executive committee, Prof. W. T. Sedgwick. An unusual feature is the committee for the reception of foreign guests. The circular explains that special efforts will be made to secure the presence of many eminent men of science from abroad.

A BUST of the late Prof. P. Schützenberger, the distinguished chemist, was unveiled at the Paris École de physique et de chimie industrielles on April 3. Prof. Schützenberger was the founder and first director of the school, and the bust is a testimony of the affection in which his memory is held by old students.

OLD students and admirers of Dr. W. K. Brooks, professor of zoology in the Johns Hopkins University, Baltimore, presented him with his portrait, painted by Mr. T. C. Corner, upon the occasion of the fiftieth anniversary of his birth on March 25. Many leading zoologists of the United States took part in this expression of esteem for Prof. Brooks.

THE autumn congress of the Sanitary Institute will be held this year in Birmingham, under the presidency of Sir Joseph Fayrer, Bart., K.C.S.I., F.R.S., commencing on September 27.

THE annual exposition organised by the Société Français de Physique will open to-day with a visit to the works of the Paris Compressed Air Company. On Friday and Saturday evening a large collection of apparatus used in recent physical investigations will be on view in the rooms of the Society; and on Saturday afternoon short addresses will be delivered by MM. Ducretet, Morin, and Hurmuzescu.

THE Liverpool Marine Biology Committee's Easter party, now at the Port Erin Biological Station, includes Mr. Isaac C. Thompson, Mr. Frank J. Cole, Mr. R. A. Dawson, Mr. H. C. Chadwick, Prof. Herdman, and several students from University College, Liverpool. Prof. Boyce and others are expected later in April. The Lancashire Sea Fisheries steamer is also at Port Erin, and several dredging and trawling expeditions are taking place. Spawn of several fishes has been obtained, and fertilised, and is now developing in the tanks. Under the care of Mr. Chadwick, Curator of the Station, the aquarium is in a flourishing condition, and contains a number of interesting animals, some of which are spawning. A recent addition to the laboratory accommodation at the Station has been completed, which gives five additional work windows for students, so that there is now plenty of room for other workers.

DR. H. M. FERNANDO will probably be the director of the Bacteriological Institute to be opened in Colombo shortly. The final plans for the building have been completed, and the work will be taken in hand at once. It is expected that the Institute will be opened by the beginning of next year.

WE learn from *Science* that the United States Senate has passed a Bill for the protection of song birds, providing that the importation into the United States of birds, feathers, or parts of birds for ornamental purposes be prohibited, and prohibiting the transportation or sale of such articles in any territory of the United States or in the District of Columbia.

THE vanguard of exploring expeditions for the season is that of Dr. Carl Lumholtz and Dr. Hrdlicka, who left the American Museum of Natural History a few days ago in search of anthropological specimens for the museum. This will be followed in a few weeks by an expedition to the North-west, undertaken also for anthropological research, by Dr. Laufer, Mr. Gerard Fowke, Mr. R. Dixon, and Mr. H. Smith.

THE most violent earthquake in California since 1872 was felt on Thursday night, March 31. The shock was felt only in Northern California. The direction of vibrations was from east to west; and they were very heavy in a small area. The seismograph showed the duration of the earthquake to have been between thirty and forty seconds at the University of California, Berkeley. Damage was done to buildings at San Francisco and Vallejo; but no loss of life has been reported.

THE death of Prof. Salomon Stricker, the distinguished professor of experimental and general pathology in the University of Vienna, at the age of sixty-five, is announced in the *British Medical Journal*. Only a week or two ago Prof. Stricker celebrated the twenty-fifth anniversary of his appointment as professor, and the occasion was celebrated by presenting him with a *Festschrift* entitled "Thirty Years of Experimental Pathology," the list of contributors including the names of E. Albert, A. Spina, G. Gaertner, Dr. E. Klein, and many other pathologists and histologists of note.

M. DE FONVIELLE writes:—The 1898 session of the international balloon scientific conference was held in Strasburg with great success. A large number of resolutions were adopted, referring to the ascent of free balloons carrying registering apparatus, and balloons with meteorological and photographic instruments. The conference passed a vote in favour of the extension of kite experiments with recording apparatus or kite-balloons to the international meteorological stations, in order to procure better information on prevailing meteorological influences. It was resolved that an international experiment

should take place at the beginning of June. In addition to the Paris, Strasburg, Berlin, and Petersburg stations, two new stations will be established in Vienna at the expense of the Minister of War, and in Brussels. The expenses will be supported by the Belgian-Deutsch Society of Astronomy, which sent to Strasburg, as their representative, M. Fievre, one of their secretaries. The next meeting will take place in Paris in 1900, on the occasion of the forthcoming exposition. Among the members present at the recent meeting were the director of the Russian Meteorological Service; Commander Kovanko, director of the Russian Aeronautical Service; Herr Assmann and Dr. Berson, of the Berlin Meteorological Institute; M. Cailletet, member of the French Academy of Sciences; M. Teisserend de Bort; Mr. Rotch, director of the Blue Hill Observatory in Pennsylvania; M. Besançon; and Prof. Heim, the Swiss geologist, professor in the Zürich Polytechnicum.

WE regret to see that Mr. James I'Anson, an occasional contributor to our correspondence columns, died a few days ago. From the *Engineer* we learn that Mr. I'Anson was born at Gateshead in 1845, and came of an old North-country family. Soon after leaving school he commenced his apprenticeship as a mechanical engineer, and in 1866 he entered the engineering works of the late firm of Charles I'Anson and Co., becoming subsequently a partner. Some time after he became managing partner, a position which he held until his retirement in 1885. Mr. I'Anson was for many years a Fellow of the Geological Society, and he also sat upon the Council of the Mineralogical Society of Great Britain and Ireland. He was a member of the Iron and Steel Institute and of the North of England Institute of Mining and Mechanical Engineers, to whose proceedings he contributed papers, as also to those of the Cleveland Institute of Engineers, the Mineralogical Society, and the British Archæological Association.

AMONG the problems interesting to the physicist and mathematician which are discussed at the meetings of the Institution of Naval Architects, few open up such a wide field of inquiry as those which form the subject of Prof. H. S. Hele-Shaw's paper, entitled "Investigation of the nature of surface-resistance of water, and of stream-line motion under certain experimental conditions," read before the recent meeting of the Institution. In a previous paper, read last July, the author showed how the flow of water in two dimensions past obstacles of various cylindrical and prismatic forms could be investigated experimentally by the use of water containing a quantity of air flowing between two parallel plates of glass, the air rendering the water turbulent where the motion was most rapid. The photographs, which Prof. Hele-Shaw reproduces, show in every case a clear line round the boundary of the solid, indicating a thin film in which shearing motion takes place past the surface, while outside this comparatively calm region streaks of air are noticeable. The figures, moreover, show the presence of regions of dead water behind obstacles with blunt edges, fully confirming the view that to minimise resistance a solid must be made to taper at its stern end rather than at its bow end. In the present paper diagrams are given showing the variations in thickness of the entrained film according to the smoothness or roughness of the surface of the solid, the addition of soap to the water, and other circumstances. A second field of experiment has been developed by the use of thin films of water flowing between parallel plates, in which the stream-lines are shown by the introduction of coloured bands. Unless the film be very thin (about 0·5 mm.), the lines of colour become blurred, especially after flowing round an obstacle. The most remarkable result is the coincidence between the stream-lines in these experiments, where we are probably dealing with a case of laminated motion of a viscous liquid largely affected by the bounding plates of glass, and the corresponding stream-lines calculated mathematically for the irrotational motion of a perfect liquid in two dimensions. It has been one of the great objections to the mathematical theory of fluid motion that the conditions imposed by the mathematician differ considerably from those occurring in practice. Prof. Hele-Shaw's investigations, however, bid fair to bring hydrodynamics within the range of experimental sciences, besides fulfilling the object for which they were primarily undertaken—that of teaching naval architects how to minimise the surface-resistance on ships.

AT the meeting of the Institution of Civil Engineers on April 5, Mr. A. H. Preece gave an account of the present state of electricity supply in London. There are now in London eleven important companies and five vestries supplying electricity, and three other companies and three vestries are taking steps to start works. Five companies and three vestries supply the alternating current, and the remainder use direct-current systems. The direct-current systems are divisible into two classes—the high-pressure and the low-pressure. In the former, rotary transformers are used to reduce the high pressure to a low pressure, while the latter produces and distributes electricity at the same pressure at which it is supplied to consumers. The direct-current systems are applicable to compact areas, and, with the use of high pressure, to scattered or isolated compact areas. The chief advantages of the direct-current system are the possibility of using storage-batteries, which can not be employed with the alternating-current systems, greater efficiency in distribution, and greater adaptability to motive power. The favourite methods of distributing electricity are to transmit current at a high pressure in heavily-insulated cables in iron pipes, and current at a low pressure in insulated cable in stoneware conduits, or in cables heavily armoured and laid direct in the ground. Rubber is now little used, paper and jute, impregnated with insulating compounds, having been extensively adopted. The electric supply industry is rapidly growing, and no less than 40,000 h.p. is now being installed in London in order to meet the demand for electricity in the immediate future.

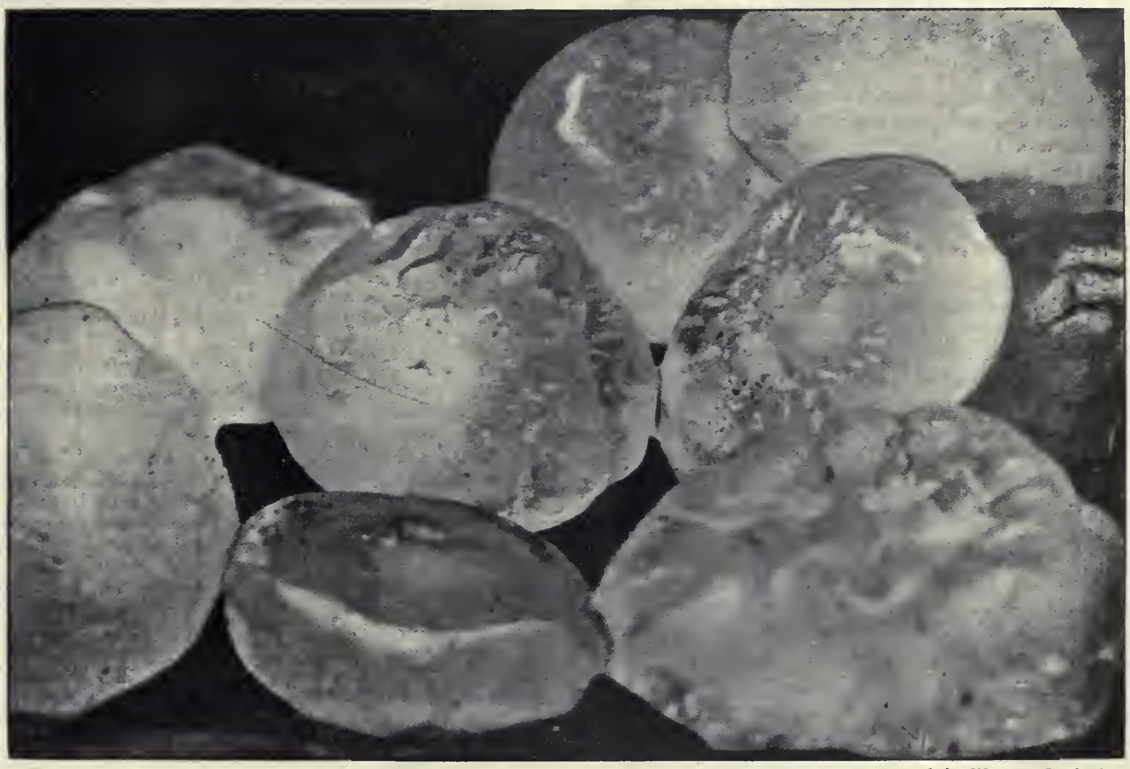
THE *Times* correspondent at Cairo makes the important announcement that M. Loret has discovered and opened at Thebes the tomb of Amenophis II, a king of the XVIII. dynasty, who reigned some 1500 years B.C. The tomb contains the mummies of Amenophis and of seven other kings, besides two mummies bearing no name, and four bodies which, though they have not been embalmed, are all in a complete state of preservation, with the features perfect. The hair upon each of these bodies is luxuriant, and the features are said to resemble to a marked degree those of the fellaheen of the present day. M. Loret's find is amongst the most interesting ever made in Egypt.

THE Central Physical Observatory of St. Petersburg has published an interesting pamphlet showing, for the whole of the Russian Empire, the absolute maximum and minimum temperatures at about 230 stations, accompanied by three maps, illustrating the above elements, and the ranges of temperature. The observations at some of the stations extend over a long series of years, *e.g.* St. Petersburg, 142 years; Moscow, 90 years; and Archangel, 80 years. The most remarkable temperatures and ranges are recorded in the Province of Yakutsk, in Siberia:—Verkoiansk, − 90° F. with a range of 182°·7; Markinskoe, − 85°·0, range 185°·2; Yakutsk, − 84°·1, range 185°·7. All these extreme minima occurred in the month of February, and the stations being a considerable distance apart, testify to their accuracy and to the great rigour of the winter of that locality. The work has been compiled by Mr. A. Varnek; but the text being in Russian only, detracts somewhat from its general usefulness.

The sources of commercial india-rubber form the subject of two Cantor Lectures to be delivered at the Society of Arts on Monday, April 18 and 25, by Dr. D. Morris, C.M.G.

An instructive article upon processes of alkali manufacture, with special reference to the works of Messrs. Brunner, Mond, and Co., appeared in yesterday's *Times*.

We have received from Mr. C. Leeson Prince the summary for the year 1897 of meteorological records which he keeps at his observatory on Crowborough Hill, Sussex. Perhaps the most important event of the year occurred on May 30, when, as he says, "a more memorable thunderstorm passed over a portion of this country than has happened within living memory." This storm, from all accounts, did not actually occur at Crowborough Hill; but from its elevated position the progress of the storm, though twenty miles distant, could be watched for a considerable time. Mr. Prince gives a reproduction of some of the hailstones which had previously fallen at Seaford during the same storm. These were found to be still larger, as will be seen by the accompanying illustration showing the hailstones in their natural size.



[*From a Photograph by Wynter, Seaford.*

A reproduction (natural size) of some hailstones which fell at Seaford during the thunder-storm of May 30, 1897.

We have received from Dr. T. Homén, of the University of Helsingfors, a laborious investigation, entitled "Der tägliche Wärmeumsatz im Boden und die Wärmestrahlung zwischen Himmel und Erde," being a continuation of a work published in 1894, in which the author dealt more particularly with earth temperature, evaporation and dew. In the present publication Dr. Homén attempts the determination of the amount of heat which enters various kinds of soil during the day, and the amount given up by radiation during the night. We are unable to give an adequate account here of the various interesting results contained in a quarto volume of about 150 pages, but we may mention that the experiments appear to have been carried out with great care. The thermometers were placed at various depths below and heights above the ground, and show clearly the effect of the soil upon the air temperature and humidity during the various hours of the day and night. The conditions of humidity were found to be very different between the level of the ground and the height of about 33 feet (at which the highest thermometers were placed), being less in the night and greater in the day in the lower than in the upper strata of air.

The Rev. W. Sidgreaves, in his report of the Stonyhurst College Observatory for 1897, gives us the results of the meteorological and magnetical observations made during the past year, with notes and comments. In addition to these observations, which have been carried out with the utmost regularity, other branches of work have been followed. Thus preparation was made for photographing trails of the November meteors, five cameras having been mounted round the object-glass end of the equatorial, but the weather proved too unfavourable. Again, 174 drawings of solar spots and faculæ were made during the twelve months, and enlarged drawings of spots near the solar limb were undertaken to obtain evidence about the level of the umbra. As regards stellar spectroscopy 240 plates were exposed, the work in hand being directed to the sequence of spectrum differences of the yellow and red stars, from those of the solar type to the type of α Herculis. An appendix to this report contains the results of meteorological observations for 1897, made at St. Ignatius' College, Malta, by the Rev. J. F. Dobson.

Science states that in addition to the plans of the Geological Survey for explorations in Alaska, the Treasury Department are about starting five or six expeditions to explore the Yukon river,

Copper river, and other water routes of the Territory, the United States Congress having granted 100,000 dollars for the purpose.

SCIENTIFIC facts are presented to the public freely and attractively in three lectures which have been arranged at the Whitechapel Free Public Library and Museum. On Tuesday Prof. Hobday lectured on "The Horse and Dog and their relations and friends." On Tuesday, May 10, Prof. W. F. R. Weldon, F.R.S., will discourse upon "Butterflies"; and on June 7, Prof. Marshall Ward, F.R.S,, will give an address upon "A Piece of Wood." Admission to the lectures is free by ticket, which can be obtained in the Museum and Library.

APPENDIX II. for 1898 of the *Kew Bulletin* is entirely occupied with a list of New Garden Plants of the year 1897, including also the most noteworthy of those which have been re-introduced after having been lost from cultivation. In addition to species and botanical varieties, all hybrids, whether introduced or of garden origin, with botanical names, and described for the first time in 1897, are included.

MESSRS. J. AND A. CHURCHILL announce that they will publish in a few days a new work on "The Blood: how to examine and diagnose its diseases," by Dr. Alfred C. Coles, illustrated with six coloured plates. They will also issue a fifth edition of "A Manual of Dental Anatomy, Human and Comparative," by Mr. Charles S. Tomes, F.R.S., with many new illustrations. The part dealing with comparative odontology has been expanded to meet the requirements of students of biology.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Grace Currie; a White-tailed Sea Eagle (*Haliætus albicilla*) from the Liautung Peninsula, China, presented by Mr. J. W. Carrell; ten Californian Quails (*Callipepla californica*) from California, presented by Captain Thos. Yardley Powles; a Common Viper (*Vipera berus*). British, presented by Mr. R. Tucker; an Egyptian Jerboa (*Dipus ægyptius*), four Egyptian Ichneumons (*Herpestes ichneumon*), six Gulls (*Larus*, sp. inc.), a Common Kestrel (*Tinnunculus alaudarius*) from Egypt, a Leopard (*Felis pardus*) from West Africa, a Reticulated Python (*Python reticulatus*) from Malacca, deposited; a Chimpanzee (*Anthropopithecus troglodytes*, ♂) from West Africa, a Rosy-billed Duck (*Metopiana peposaca*, ♀) from South America, purchased.

OUR ASTRONOMICAL COLUMN.

THE DOUBLING OF THE CANALS ON MARS.—The origin of the doubling of the canals visible on the surface of the planet Mars has again come to the front, and this time M. Antoniadi has put forward an explanation. His suggestion is that the doubling is only a phenomenon caused probably by the eye of the observer; in fact, it is the result of slight focussing errors when observing these markings. A full account of this curious cause of error is contributed to *Cosmos* (No. 687) by M. Th. Moreux, and M. Antoniadi himself gives a complete summary of his suggestion in the *Bulletin de la Société Astronomique de France* for April. According to the latter, a thin line, when gradually put slightly out of focus, becomes slowly double, the inner parts of which are blurred; in fact, a regular germination is observed. In addition to this, he finds that if several lines be made to cross at a point, all of these do not become double, but only certain of them. Not only do straight markings, but round and elongated spots become alike doubled. At the end of his paper, after remarking on the curious phenomenon of canals, as actually observed, becoming double in the course of a few hours, he says:—

"Ainsi, si Mars est couvert de 'canaux,' la vision imparfaite devra dédoubler ces lignes. Pareille vision indistincte peut provenir, ainsi que nous venons de le voir: 1° d'une minime erreur de mise au point; 2° d'oscillations diplopiques (fatigue) de l'œil. Voila ce qui doit fatalement arriver, el ce qui arrive en réalité."

M. Camille Flammarion tells us in the same journal that M. Adolphe de Boë, of Anvers, in the year 1891 suggested, in a letter to him, that this doubling might be the result of secondary images which, under certain conditions, might be formed in the eye. M. Flammarion is, however, no great believer in this idea, as it does not seem to sufficiently explain all the phenomena of doubling, germination, &c., which have been observed on the surface of this interesting planet, although the arguments brought forward reproduce very ingeniously the greater part of the observations. With him we echo the sentiment of wishing to know what M. Schiaparelli has to say on the subject.

COMET PERRINE.—The latest elements and ephemeris of this comet have been calculated by Prof. H. Kreutz, who gives the results in No. 4 *Circular* recently distributed.

The elements computed from the observations of March 19, 23, 27 and 31, differ slightly from those we have previously given, being:—

$$T = 1898 \text{ March } 17{\cdot}37558 \text{ Berlin M.T.}$$

$$\left.\begin{aligned} \omega &= 47^\circ\ 34'\ 12''{\cdot}1 \\ \Omega &= 262\ 33\ 59{\cdot}6 \\ i &= 72\ 27\ 48{\cdot}1 \end{aligned}\right\} 1898{\cdot}0$$

$$\log q = 0{\cdot}040842$$

The ephemeris for the ensuing week is as follows:—

1898.	R.A. h. m. s.	Dec.	log r	log Δ	Br.
April 14	23 7 15	+40 47·7	0·0757	0·2233	0·77
15	12 13	41 32·9			
16	17 15	42 16·9			
17	22 20	42 59·7			
18	27 27	43 41·3	0·0851	0·2330	0·71
19	32 37	44 21·6			
20	37 49	45 0·6			
21	43 3	45 38·4			
22	23 48 19	+46 15·0	0·0953	0·2438	0·64

It will be noticed that the brightness of this comet is gradually decreasing, and by the end of the month it will be about half that at the time of discovery.

THE APRIL LYRIDS.—As pointed out in this column on March 31 (p. 519), the April shower of meteors is due on 19–20 of this month. The conditions for viewing these bodies if they should be numerous will be very favourable, as the moon will be absent. As Mr. Denning tells us, the periodical maxima of this stream of Lyrids has a computed time of revolution of 415 years, a brilliant display having occurred on April 20 in the year 1803. The radiant point is 270° + 32°.

THE MEUDON OBSERVATORY.—Prof. Janssen is evidently bringing together a very strong force at the Astro-Physical Observatory at Meudon. We hear now that, in addition to the other experienced astronomers who are working there, M. Deslandres has been transferred from Paris, and will in future continue his valuable spectroscopic researches at Meudon.

PREHISTORIC RUINS OF HONDURAS AND YUCATAN.

IN 1891 the Directors of the Peabody Museum secured from the Government of Honduras (through the liberality of Mr. C. Bowditch, of Boston) the right to explore the ruins of Copan, and to take away half of the objects found in the excavations, during a period of ten years. The preliminary report of the exploration,[1] now published by the Directors of the Museum, gives the result of the first two years' work, and is accompanied by a plan and many excellent photographic plates.

All those interested in American archæology must be for ever grateful to the Committee directing the expedition for one instruction given to the explorers; it was to the effect that a wall should be built round the principal group of ruined structures and carved monoliths, so as to save them, if possible, from further destruction. This work has now been most satisfactorily carried out, and the ruins, which were always safe from approach on the river face, are now enclosed on the land side by a substantial stone wall nearly one mile in length.

[1] *Memoirs of the Peabody Museum, &c.* Vol. i. No. 1: "Prehistoric Ruins of Copan, Honduras." "A Preliminary Report of the Explorations by the Museum, 1891–95."

Examination and excavation have thrown no light on the age of the buildings; in fact, the further examination has only complicated the problem, as clearer proofs are forthcoming that the mass of masonry has grown up in the course of ages, old foundations being enlarged and covered in turn by new buildings. One of the most interesting discoveries made during the explorations is connected with the great hieroglyphic stairway which leads to the summit of one of the largest foundation mounds. The steps of this stairway had become disjointed and displaced, so that it is not easy to determine the exact plan of its construction; and it was probably in order to gain further information on this point that an excavation was commenced near the foot of the steps, which revealed the fact that the hieroglyphic stairway had been superimposed on an earlier stairway, which also had a clear cut inscription on the face of each step. A description of these stairways has been deferred until further exploration leads to a better understanding of their structure; and it is to be hoped that the greatest care has been taken in numbering and recording the position of the stones, so that the continuity of the glyphs in the inscriptions may be retained, as the result of a comparison of the initial dates of the two inscriptions (one of which is in the rarer form of picture writing) will probably prove to be of the greatest value.

FIG. 1.—Foot of the hieroglyphic stairway.

No regular burying-place has been found at Copan, but a number of isolated tombs have been explored, in which human bones were discovered in more or less disintegrated condition. The human incisor teeth were found, in many instances, to be ornamented by the inlaying of a little circular bit of jadeite, fitted into a hole drilled into the front of the tooth. These jadeite ornaments are slightly rounded outward, and highly polished. Many interesting pieces of pottery were secured during the excavations, some decorated with painted designs, others (such as the terra-cotta vase in the form of the head of a carnivorous animal, figured on p. 48 of the Report) remarkable for the artistic skill shown in the modelling. The most interesting object of all, however, was not a piece of pottery, but the actual skull of a peccary covered with beautifully incised figures and hieroglyphs. I have had the good fortune to be able to examine this skull in the Peabody Museum, and can only express an earnest hope that photographs of it, and drawings of the incised ornament, may be included in the further publications which are promised us.

During the second year's work a sad event occurred in the death of Mr. J. G. Owens, the leader of the expedition, who contracted a malignant fever during a journey to the coast, and died soon after his return to the ruins, where he lies buried in the great Plaza surrounded by those strangely carved monoliths in which he had learned to take so keen an interest.

The Exploration Committee of the Peabody Institute has not confined itself to organising expeditions in Honduras only; it has for some years worked with equal success in furthering the examination of ancient ruins in the peninsula of Yucatan. There, under the direction of Mr. Edward H. Thompson, for some time the United States Consul in Merida, a thorough examination has been made of the ruins of Labná; but, unfortunately, the report on that portion of the work has not yet been made public, and the second article in the *Memoirs* of the Museum deals only with the exploration of the Cave of Loltun,[1] which Mr. Thompson undertook in 1888 before setting to work at Labná—from which it is twelve miles distant—and continued in 1890-91.

One peculiarity of Yucatan is that it is a country without any rivers. The copious rainfall soaks through the porous limestone rock, and it is to the pools in the deep caves or "cenotes" that the Indian of to-day looks for his supply of water, as his forefathers did before him. Under such conditions the caves were sure to yield to the explorer many signs of human visitation, but it was of the greatest importance to ascertain whether the evidences of human handiwork should be attributed only to the race inhabiting the land at the time of the Spanish conquest, or

FIG. 2.—Two steps from the hieroglyphic stairway.

[1] *Memoirs of the Peabody Museum*, &c., vol. i. No. 2: "Cave of Loltun, Yucatan." "Report of Explorations by the Museum, 1888-89 and 1890-91," by Edward H. Thompson.

whether they could be ascribed to some earlier and more primitive race.

The interest attaching to the result of Mr. Thompson's labours has been somewhat discounted by the publication in 1896 of the admirable treatise on the caves of Yucatan by Mr. Henry Mercer, but to Mr. Thompson must remain the credit of having been first in the field.

Mr. Thompson's report is accompanied by some capital photographs of the rock carvings, taken by Mr. H. N. Sweet and

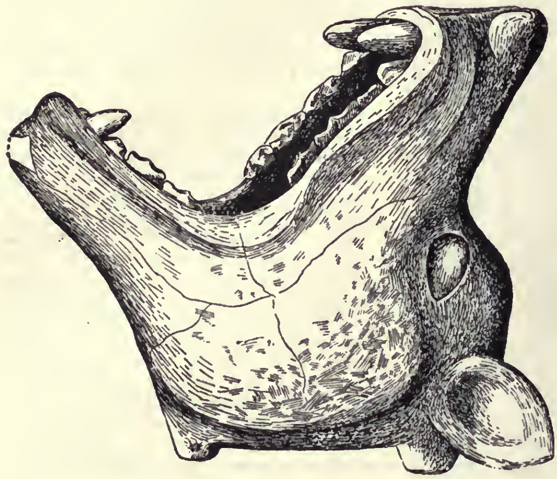


FIG. 3.—Terra-cotta vase (⅓ size)

Mr. M. H. Saville, showing them all to be rude and primitive in character, with the single exception of a life-sized human figure with the mutilated remains of a date expressed in the Maya notation above its head, which is just such a figure as one might find on the walls of the ruined temples above ground.

Mr. Thompson's main conclusion is that from the earliest period of the cave's use as a human habitation the people seem to

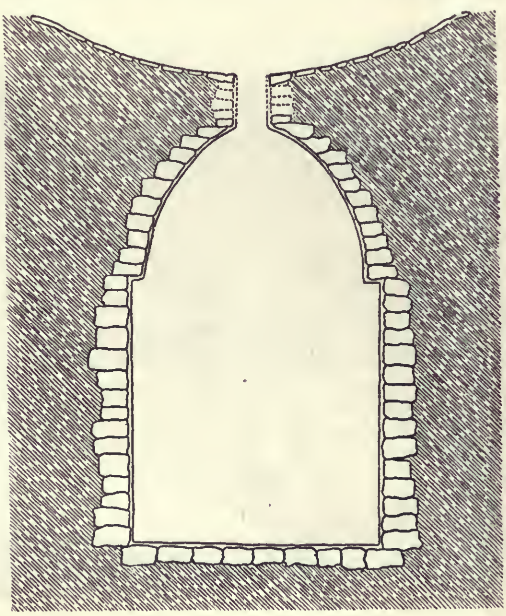


FIG. 4.—Section of a chaltune.

have been of the same manners, religious customs, and household habits as those who built the great structures above ground now in ruins. Mr. Mercer, after pointing out that the caves were not properly dwellings but rather temporary halting-places, has given it as his opinion, (1) that no earlier inhabitant preceded the builders of the ruined cities of Yucatan; (2) that the people revealed in the caves had reached the country in geologically recent times; (3) that these people, substantially the ancestors of the present Maya Indians, had not developed their culture in Yucatan, but had brought it with them from somewhere else.

In a country where water is so scarce, it is only reasonable to suppose that the inhabitants would have devised some means of storing the precious fluid; and in the existence of numerous "chaltunes" we have almost certain evidence of the means of storage most commonly employed. These chaltunes are "single chambers of a vault-like appearance, built from ten to fifteen feet beneath the surface of the ground, and communicating with the outer world by means of a narrow well-like opening placed near the apex of the vaulted roof." They are somewhat irregular in shape, but the prevailing form is shown in the following section.

Mr. Thompson paid particular attention to the chaltunes amongst the ruins of Labná,[1] a neighbourhood where—if the opinion that they were used for the storage of water be correct—it is likely that they would be found in considerable numbers, as the nearest permanent water supply is found at the Cave of Loltun, twelve miles distant. Mr. Thompson is of opinion that many of the rougher class of chaltunes were formed in the cavities or pockets from which the white earth, called by the natives "zahcab," had been taken. "This earth is of a

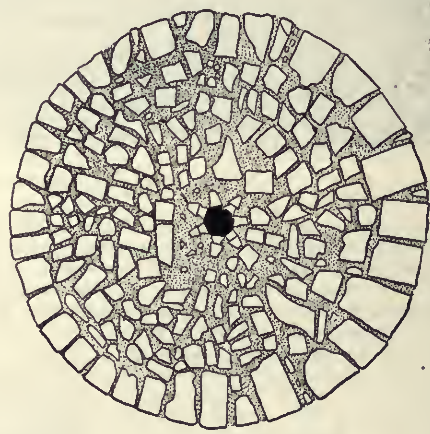


FIG. 5.—The mouth of a chaltune.

peculiar character, and served the ancient builders, as it does those of the present day, as a building material to mix with lime in place of siliceous sand, which is practically unknown in Yucatan." The other chaltunes are well-built chambers, having their walls, roof, and floor of dressed stones, and finished with a coating of fine, hard stucco. In the ruins of Labná, each edifice and each terrace was found to be provided with one or more of these subterranean chambers, the largest of which, however, would not hold more than 10,000 gallons.

Many of the chaltunes had become hopelessly ruined, and many were filled up with earth and rubbish; but some of them had been purposely sealed up by the ancient inhabitants, and these presented a new and interesting field for investigation. Human bones and various objects of human workmanship were found among the deposits at the bottom of the chambers; and Mr. Thompson is led to the conclusion that many of these singular structures, after having been first used as reservoirs, were finally used as depositories for human remains, probably secondary burials, in connection with some special rite, after which the entrance of the chaltune was closed and cemented.

ALFRED P. MAUDSLAY.

P.S.—While the foregoing was in the printer's hands, an article on Copan has been brought to my notice, published in the *Century Magazine* for January, in which Mr. Gordon states that he has finished his work on the hieroglyphic stairway. It proves to have been a single flight of steps, and not one stairway built over another. The illustration given on p. 569 shows the foot of the stairway as it was at first disclosed

[1] *Memoirs of the Peabody Museum*, vol. 1. No. 3: "The Chaltunes of Labná, Yucatan." "Report of Explorations by the Museum 1888–89 and 1890–91," by Edward H. Thompson.

by Mr. Owens's excavation. The disjointed stones of the upper part of the stairway (some of which have already been cleared away) had slid down bodily from above and, until the excavation was made, had completely hidden the lower part of the stairway.

It is to be hoped that the next part of the *Memoirs of the Peabody Institute* will give the details of this interesting work, and a more accurate (if less ambitious) drawing than that of the "restored" stairway published in the *Century Magazine*. If it has been possible to preserve the continuity of the inscription on the steps, Mr. Gordon's labours will have added to our store one of the longest and most valuable inscriptions yet found in Central America.

Surely it is through an unintentional error that the drawing of the Jaguar stairway, on page 409 of the *Century*, is ascribed to Henry Sandham. A. P. M.

RECENT PAPERS ON GLACIATION.

AT the Toronto meeting of the British Association the numerous papers bearing on the glaciation of the North American continent were of exceptional interest to the British student of glacial geology, inasmuch as they brought prominently to mind the methods adopted by the Canadian and American glacialists, which differ in many respects from those to which we have become accustomed on this side of the Atlantic.

In no branch of earth-lore is the influence of his environment more strongly impressed upon the worker than in stratigraphical geology, and the effect of the simple topographical forms and of the enormous extent over which the glacial deposits are distributed in North America, has been to give a broader grasp and bolder tone to the general run of its glacial literature. This was admirably illustrated by the work brought forward at the meeting. In the British Islands, from the abundance of natural and artificial sections as well as from the complexity and narrow limits of the topography, the lithological composition of the drift deposits is usually made the pivot of the studies, while in America it is rather the arrangement of the drift in regard to the general physical features which is held to be of paramount import.

The following comments on the papers read at Toronto have been written from the standpoint of a British glacialist anxious to find wherein he might profit by the adoption at home of the Transatlantic methods.

To realise the extent of the field in North America it must be remembered that the total area of the Dominion of Canada, about 3,616,000 square miles or not much less than the whole of Europe, can show, in one form or another, traces of the Great Ice Age in every part, and that the same glaciated area further extends over a region about one-fifth as large to the southward of the Canadian border. It is not surprising, then, that the study of glacial phenomena should have attracted so many able workers in Canada and the United States.

The exploratory work of Russell, Wright and others upon the existing glaciers of Alaska, and of Chamberlin, Peary, Barton and others upon the edge of the ice-sheet in Greenland has been more readily assimilated by American than by British glacialists, and its influence is perceptible throughout their researches. It is true that the Danish explorers had already made known to us the leading facts relating to the latter region, but their studies were not perhaps made so directly from the standpoint of the glacial geologist as those of the above-mentioned observers, nor were their results so accessible to the English-speaking geologists. But since Russell, by his investigation of the Malaspina Glacier, with its forested moraine-covered margin sheltering a varied fauna and flora, has shown how widely different are the conditions of Piedmont ice and Alpine glaciers, and since Chamberlin, in describing the mode of occurrence of the detrital matter in the basal layers of Greenland ice-tongues, has thrown so much new light on the whole question of drift-deposition, the British glacialist would do well to recognise, with his colleagues across the Atlantic, that the glaciers of the Alps do not afford the best introduction to the study of glacial geology. It is clear that the Alpine conditions are, in many respects, very different from those under which the ice-sheets of the Glacial period did their work.

As regards the cause of the Great Ice Age, we heard at the Toronto meeting two interesting communications. That of Prof. T. C. Chamberlin, outlined in a former number of NATURE (September 16), was avowedly altogether speculative, and belonged to the domain of earth-physics rather than to geology in the ordinary sense. The other was that in which Dr. J. W. Spencer ably advocated his well-known views on the continental elevation of the Glacial epoch.

Dr. Spencer described a large number of drowned valleys, often extending from the mouths of the great modern rivers across the submarine plateaus at various depths, reaching to even 12,000 feet or more, and recognisable as far northward as Labrador. He stated that upon tracing northward the deposits occupying the great valleys, he found that glacial accumulations occur in New Jersey between the Lafayette formation, which is the latest horizon dissected by the great valleys, provisionally regarded as of late Pliocene age, and the Columbia formation, which is mid-Pleistocene. From all these considerations he concluded that the eastern portion of North America stood more than two miles above the sea during the earlier Pleistocene epoch.

On other evidence he judged that the Mexican plateau was mostly depressed to near sea level during the times of the high elevation of the eastern portion of the continent; and that, with the subsidence of the eastern region, the western side of the continent was elevated from 6000 to 10,000 feet or more. The separation of the Atlantic and Pacific Oceans he regards as only of recent date. These changes of levels and the dependent variations of currents, &c., seem, in his opinion, to be sufficient cause for the Glacial period.

As Dr. Spencer pointed out, his views are practically those which have been advocated by Lyell and many others. But while a pre-glacial elevation of the North American continent is generally acknowledged by geologists, the extent of this elevation is not usually admitted to have been even approximately as large as Dr. Spencer would claim, and the difficulties in accounting for the widespread glaciation of the Northern Hemisphere by the effects of elevation alone are so great that the defenders of this hypothesis are at present few.

There is a somewhat remarkable blank in the evidence to hand in North America as to the conditions immediately antecedent to the Glacial Period, nothing equivalent to the Forest Bed Series and associated pre-glacial deposits, of which we possess such excellent sections on our Norfolk coast, having yet been discovered. For this reason the paper of Mr. R. Chalmers, of the Geological Survey of Canada, on the pre-glacial decay of rocks in Eastern Canada, was of especial interest. Mr. Chalmers showed that in the region he described, beds of decomposed rock, of variable thickness and more or less modified, occur wherever the surface of the rocks has not been abraded by Pleistocene ice, though boulder clay may often be found overlying them.

He gave the following general section of these beds in descending order:—(1) Transported and stratified water-worn gravel with beds of fine sand and clay. (2) Coarse stratified gravels, usually yellow and oxidised, the materials wholly local. (3) Sedentary rotted rock, passing into solid rock beneath.

There seems at present to be no evidence as to the precise age of these beds in Eastern Canada; but Mr. Chalmers pointed out that somewhat similar deposits occurring at the western base of the Green Mountains in Vermont, have yielded vegetable remains by which Lequereux, many years ago, referred them to the Miocene. He concludes that the general aspect of the dry land in Eastern Canada previous to the Glacial period must have been nearly similar to that of the region south of the glaciated zone in North America.

The occurrence of similar local rubble in sheltered situations beneath the drift has often been noted in the British Islands, and the ease with which such loose-lying material would become incorporated into the basal layers of an advancing ice-sheet has been frequently discussed. On both sides of the Atlantic it seems more probable that the greater bulk of the glacial deposits was derived from this source, rather than from the direct erosive action of the ice upon the solid rocks.

With regard to the initial stages of the glaciation, while the European glacialist looks to the highest ground in the northern part of his continent and its islands—to the mountains of Scandinavia, of Scotland, England, Wales and Ireland, and of Switzerland—as the great gathering grounds, it is generally recognised that in North America, with the exception of the Cordilleran mass in the extreme west, the glaciation commenced and spread from the comparatively low ground in the north of the continent and moved southward against the slope of the land, the mountains near its south-eastern margin being

obstacles in its course rather than aids to its accumulation. It is, indeed, probable that in Eastern Europe too much stress has been laid on the importance of the hill-ranges as glacial centres, since there is much evidence to indicate that, at any rate during the maximum glaciation, the movement, and probably therefore the growth, of the great sheets was more or less independent of the orographic features. In this connection the explorations of Mr. J. B. Tyrrell, of the Canadian Survey, in that birthplace of ice-sheets the desolate region to the westward of Hudson Bay, are of the highest importance. In his paper on the glaciation of North-western Canada, Mr. Tyrrell stated that no evidence was discovered of any great elevation of this central area in Glacial, or immediately Pre-glacial times, and it would seem not improbable that the land then stood at about the same height above the sea as at present; and that the moisture giving rise to the immense precipitation of snow would probably be derived from the adjacent waters of Hudson Bay and the Arctic Ocean.

In the region immediately west of Hudson Bay, the earliest glaciation of which he could recognise any traces flowed outwards from a gathering-ground which lay north or north-west of Doobaunt Lake. Subsequently this gathering-ground moved south-eastward, until it centred over the country between Doobaunt and Yath-kyed Lakes. From one or other of these centres the ice seems to him to have flowed westward and south-westward to within a short distance of the base of the Rocky Mountains; southward, for more than 1600 miles to the States of Iowa and Illinois: eastward, into the basin of Hudson Bay; and northward, into the Arctic Ocean.

He applies the name Keewatin Glacier to this central continental ice-sheet, which in general character appears to have been somewhat similar to the great glacier of north-western Europe, with a centre lying near the sea-coast, a steep and short slope seaward, and a very much longer and more gentle slope towards the interior of the continent. But, remarked Mr. Tyrrell, there was this difference between the two, that the centre of the latter was over a high rocky country; while the centre of the former was over what is now, and was probably also then, a low-lying plain, on which the snow accumulated to such depths as to cause it to flow over country very considerably higher.

This great glacier, in the different stages of its retirement down gradually descending slopes, caused many temporary extra-Glacial lakes to be formed, which were drained one after another as it retired to still lower country. Before it had withdrawn from the Winnipeg basin, Mr. Tyrrell thinks that it was joined by an advancing glacier from the east, and in front of the two, Lake Agassiz, one of the largest of the extra-Glacial lakes, was formed. During the final stages, its general gathering-ground is believed to have moved still nearer to the coast of Hudson Bay, and to have broken into several separate centres; and Mr. Tyrrell notes that after its retirement the land in the vicinity of Hudson Bay stood from 500 to 600 feet below its present level, and gradually rose to its present height.

The shifting of the centres of glaciation at different stages of the Great Ice Age, to which Mr. Tyrrell referred, seems to be a well-recognised characteristic in North America, though it is diversely explained. Dr. G. M. Dawson, in the admirable summary of Canadian Geology in the new Handbook for Canada prepared for the Toronto meeting, notes that the western part of the Great Plains was invaded at an early stage by large glaciers issuing from the Cordilleran ice-sheet through the main valleys of the Rocky Mountains, while at a later period, when this ice had shrunk back, a newer series of glacial deposits was spread out in the same area, largely composed of Laurentian and Huronian débris transported from the north-east.

Dr. Dawson, while acknowledging that the evidence is not satisfactory, is still inclined to think that these latter deposits may be in part of marine origin, and that they indicate great relative and absolute changes of level in this region in Glacial times.

In eastern Canada also "it has been found by Mr. Chalmers that when the Laurentide Glacier invaded the lowlands to the west of Quebec, the Appalachian glacier had either greatly decreased or had vanished" (Handbook, p. 30).

In England the drift deposits of the eastern and midland counties show many similar indications of successive glaciation from different centres, and until recently the tendency has been, as in America, to ascribe the facts to the intervention of warm inter-glacial periods. But since it is now generally acknowledged that, given a sufficiently low temperature, the prime factor in the accumulation of the ice-sheets has been the excessive snowfall rather than the extreme cold, may not the whole of the phenomena have been due to the gradual shifting of the areas of greatest precipitation, brought about, as a secondary effect, by the growth of the ice-sheets themselves?

It will be observed that Mr. Tyrrell, in common with all American glacialists, has recognised an up-hill movement of the ice sheet. The possibility of such movement has frequently been questioned on our side of the Atlantic, in spite of the occurrence of transported boulders in various parts of the British Islands at levels considerably higher than their source. But the extent of the uplifts in such instances is slight as compared with that described by Prof. C. H. Hitchcock in his paper on the Southern Lobe of the Laurentian Ice-sheet.

Prof. Hitchcock pointed out that one great lobe of the Laurentide Glacier went southward through the Champlain and Hudson valleys, moving from a plain near sea level, over the highest mountains in New England and New York, 6000 and 4000 feet in altitude, as shown by the transport of the boulders and by the direction of the glacial striæ. As indicative of the distinctiveness of this lobe he described how the striæ diverge from the central line "much like the barbs of a feather from the central shaft," and how the terminal moraines are looped round the area rudely at right angles to the direction of the ice movement. The initial gathering ground for this portion of the ice-sheet seems to have lain to the eastward of Hudson Bay; hence it is sometimes termed the Labradorian Glacier.

The lobate character of the southern termination of the ice and the tendency of these lobes to spread outwards from a centre is strongly insisted upon by all the American glacialists who have studied the peripheral portions of the glaciated area, and the delimitation of these lobes and the discussion of their chronological relations has been made the subject of much recent research. The matter is worthy of more attention than it has yet received with us, for as was shown by Mr. H. B. Woodward in a paper, read at Toronto, on the Chalky Boulder-clay of our West-midland counties, some at least of the characteristic phenomena can be recognised in this country also. The fact that in America these distinct lobes did not reach their maximum development at the same time, and that the overlapping of one great tongue upon the area previously occupied by another is frequently indicated, has given rise to much difference of opinion as to the length of the time-interval separating these different stages of growth and retreat. Prof. T. C. Chamberlin, who gave a lucid demonstration of his views[1] at Toronto, is of opinion that the glacial phenomena of the northern United States indicate two or more successive and distinct periods of glaciation separated by mild interglacial intervals, while other observers are inclined to agree with Dr. G. F. Wright, who though acknowledging wide oscillations of the ice-margin, regards the growth and wane of a single sheet as sufficient to account for all the facts.

In America, therefore, as in Europe, in spite of the prolonged discussion, not only is the number of the supposed warm inter-glacial periods still unsettled, but the evidence for even one such interval is challenged. The whole question is largely a legacy from the brilliant theorising of the late Dr. J. Croll, and with the breakdown of his captivating generalisations it has become necessary to reconsider the whole evidence which has been adduced, in support of them, on both sides of the Atlantic, before a safe conclusion can be reached. It is suggestive that while the explorers of the peripheral areas of the old ice-sheets are usually steadfast in their belief in such periods, those whose investigations lie more centrally to the regions of accumulation, both in Europe and in America, are more frequently in favour of the unity of the great glaciation. Yet even this localisation of opinion is capable of two opposite applications.

One of the strongest threads in the evidence for an inter-glacial period in North America is furnished by the sections in the vicinity of Toronto. Since Dr. G. J. Hinde described these deposits in 1877, fresh excavations in the Don Valley have revealed new facts of importance. Prof. A. P. Coleman, in his paper on the subject at the British Association meeting, stated that in the Don Valley a lowest till is seen, upon which rest 18 feet of sand and clay containing many unios and other shells, as well as leaves aud pieces of wood. Some of the unios do

[1] These are ably stated by Prof. Chamberlin in the chapter on the Glacial phenomena of North America in the third edition of Prof. Jas. Geikie's "Great Ice Age."

not now live in Canadian waters, but are found in the Mississippi; and several species of trees now belonging to the States to the south occur with them, indicating a climate decidedly warmer than the present. Above this come stratified clay and sand, with a caribou horn and remains of insects and plants belonging to a colder climate than the present. This set of clays and sands is best shown in the cliff-section at Scarborough Heights a few miles to the east, where the series rises 148 feet above Lake Ontario, and contains many species of extinct beetles, as well as shell-fish, mosses, and wood of hardy trees. A complicated middle till overlies these beds which were deeply eroded before the advance of the ice. Another less important fossil-bearing bed occurs above the middle till at elevations up to 240 feet above the lake, and is followed by a third till. Prof. Coleman notes that great changes have occurred in the level of the water, the lake being much lower than at present before the first glacial advance and after the first interglacial time, and that during the deposition of the middle till, and also while the last sheet of till was being deposited, the water stood from 250 to 300 feet above the present level of the lake, which is 247 feet above the sea. In his opinion the length of time required for the first interglacial period is probably to be estimated at thousands of years; and during this time he thinks the ice-sheet of the Laurentide Glacier must have completely disappeared.

As a result of this paper a British Association Committee was appointed to investigate these deposits further by means of excavations. The palæontological evidence is held to imply that, as above stated, the climate when the Don Valley deposits were laid down was such as would be incompatible with the presence of ice anywhere in the Laurentide area, and that this warm period was followed by a later glaciation, of which the clearest evidence is contained in the section at Scarborough Heights. The identification of the warm-climate horizon in this cliff-section is especially desirable, and is one of the results which may be hoped from the Committee's investigations.

In describing the drift phenomena of the Pacific coast around Puget Sound, which in most respects compare very closely with those of our own islands, Mr. Bayley Willis put forward the hypothesis that the channels of the Sound, which have usually been considered submerged valleys, are the hollows remaining after repeated glacial invasion of a wide and diversified depression, during which the earlier divides were built upon, and transformed into plateau-like eminences of glacial drift, whereas the occupation of the valleys by glacial ice, particularly in the stagnant stages of retreat, prevented their being permanently filled; so that with the final retreat of the ice the moulds of glaciers remained as the channels of the Sound.

This view accentuates the undoubted fact that the accumulation of glacial débris has been greater around the margins of the old ice lobes than in the more central areas, and it may be applied to some extent to our own islands, where the persistence since pre-glacial times of the shallow basins of the North Sea and the Irish Sea appears to indicate that a larger proportion of the material transported by the ice-sheets which once filled them has been deposited around their margins than within their beds.

The old lake-beaches, incidentally referred to by Prof. Coleman and Mr. Tyrrell, occupy a large place in the studies of the American glacialists, while in the British islands, in spite of the rough pioneer work of the late Prof. Carvell Lewis, the subject has scarcely been touched. The scope for these researches in our country is, of course, limited; but the classical example of the parallel roads of Glen Roy is sufficient to prove that the phenomena are not unrepresented. In America two distinct types of old lakes have been recognised—those like Lake Agassiz and Lake Warren, which were formed in front of the retreating ice-margin, and those like Lake Nipissing and Lake Iroquois, which owed their position to differential earth movements.

The literature in regard to both types is already very extensive, and is not altogether satisfactory. Especially in the case of the glacially-dammed waters, their reputed vast extent, their impersistence of level and brief duration, the later modification of their sites by earth movements, and above all the obscurity of their traces over wide tracts of uncleared forest, makes it certain that while the broad fact of their former existence may be undoubted, the delimitation and correlation of their boundaries must be regarded in most cases as more or less provisional. With gravelly deposits of all kinds spread over such an enormous extent of territory it must necessarily be difficult to pick out an individual shore-line unless this can be traced almost continuously, which is rarely possible. In certain regions, however, the study has been carried on under more favourable conditions, with most interesting results. Thus Prof. H. Leroy Fairchild, in describing the glacial phenomena of Western New York,[1] showed how the long upland valleys of that part of the State contain the terraces of lakes which have overflowed southward across the watershed, leaving well-marked channels of glacial drainage, and how as lower passes were opened by the retreating ice the waters of these lakes sank to corresponding levels. The highest of the continuous shore-lines of this region is recognised as being that of the glacial Lake Warren, which is believed to have stretched from the western end of the basin of Lake Ontario over the whole or the greater part of the Great Lakes.[2]

Below this are found several less continuous terraces, probably marking different stages of the depletion of the lake, until at about 500 feet lower the Iroquois shore-line is reached, which appears to have been the immediate forerunner of the Lake Ontario of the present day. This beach is admirably developed in the vicinity of Toronto, and the main facts regarding it were demonstrated by Mr. Gilbert and Dr. Spencer during the meeting. Dr. Spencer considers that it is an old sea-beach; but in this he is at variance with most of the American glacialists, who hold that it, like the higher beaches, is of fresh-water origin.

These old beach-lines are of especial importance in that they reveal considerable differential uplift during late-glacial and post-glacial times. On this point all the students of the subject are agreed, and it is, of course, regarded therefore as a factor of prime importance in the later history of the lake basins. It was insisted upon by Mr. F. B. Taylor in an interesting communication on the relation of the Champlain submergence to the Great Lakes and to Niagara Falls. Working on the same lines as Mr. Gilbert had done, Mr. Taylor showed that an old shore-line, named the Nipissing Beach, surrounds a large portion of the Upper Great Lakes, and leads to a low col at the east end of Lake Nipissing. The formation of this beach he supposes to have been contemporaneous with the Champlain submergence by which the St. Lawrence Valley and the Champlain depression became arms of the sea, so that during this period the Upper Great Lakes had their outlet by way of the Nipissing Pass and the Ottawa River into the St. Lawrence, leaving only the discharge of Lake Erie, or one-ninth of the total volume, to occupy the Niagara River. Mr. Taylor stated that the Nipissing beach is tilted so that it falls regularly towards S. 27 W. at the rate of nearly 7 inches to the mile, being 110 to 115 feet above the present surface of the north-eastern part of Lake Superior, while not far east of Duluth it has sunk to the water level, and if its plane were projected it would pass 100 feet below the lake-level at Chicago. He gave reasons for considering that the tilting was caused by the same uplift which raised the Champlain Valley, and that one effect of this movement was to close the Nipissing outlet and to open that at Port Huron, by which the entire discharge of the lakes was sent into the Niagara. The result of these changes is to be found, according to Mr. Taylor, in the cañon below the Falls, the narrow and shallow gorge of the Whirlpool Rapids indicating the work of the comparatively feeble stream from Lake Erie, while the Upper Great Gorge has been excavated since the closing of the Nipissing outlet, which, accepting the known rate of recession of the Horse-shoe Fall as the principal datum, may have taken place from 5000 to 10,000 years ago.

These researches may well serve to illustrate the complexity of the problem whenever an attempt is made to transmute the term of geological processes into an equivalent in years. Simple multiplication and division without a steady-going chronometer can never suffice, nor is the time-unit that serves for a man's life ever likely to help us much in measuring the duration of cosmic processes.

As regards the differential movement, Spencer and Gilbert are of opinion that it is still in progress, and will eventually submerge Chicago and dry up Niagara. In a recent paper[3] Gilbert has even ventured to predict in years when this may be expected.

G. W. L.

1 This paper is printed in full in the *Geological Magazine*, and is therefore easily accessible to British geologists.

2 An admirable summary of the work of Spencer, Gilbert, and others in elucidating the history of this great body of water will be found in a paper by Mr. Warren Upham on "Glacial Lakes in Canada," *Bull. Geol. Soc. of Am.*, vol. ii. (1891) pp. 243–276.

3 "Modification of the Great Lakes by Earth Movement," *U.S. Nat. Geographic Mag.*, vol. viii., September 1897, p. 233 (see Nature, December 30, 1897).

MIERSITE, A CUBIC MODIFICATION OF NATIVE SILVER IODIDE.

SILVER IODIDE is remarkable in being one of the few substances which undergo a contraction in volume as the temperature increases. This contraction is uniform until about 146° C. is reached, when there is a further sudden contraction of considerable amount, after which the substance expands. The sudden contraction at 146° is accompanied by a change in all the physical properties of the substance, the pale yellow, hexagonal modification which exists at ordinary temperatures, being then changed into a bright yellow, cubic modification. On cooling the reverse phenomena are observed.

From this behaviour it would be expected that only the pale yellow, hexagonal modification would be found as a natural mineral, and as a matter of fact the only pure silver iodide so far known is the hexagonal species iodyrite. The existence of a cubic modification has, however, long been suspected from the occurrence of iodine in the cubic mineral iodobromite ($2AgCl.2AgBr.AgI$). This probably represents the artificial cubic modification which is stable above 146°, in which case the natural crystals of iodobromite should be pseudo-cubic; in fact, pseudomorphs of the hexagonal modification with the external form of the cubic modification. This would be strictly analogous to the pseudo-cubic leucite and boracite, which become isotropic when heated to a definite temperature.

The new mineral, miersite, is, however, quite distinct from these, and proves that silver iodide is trimorphous. The principal characters of the three modifications are :—

Iodyrite	Miersite	Iodobromite
Hexagonal	Cubic	Cubic
Hemimorphic	Tetrahedral	Holohedral
Twin plane, a pyramid face	A tetrahedron face	Not twinned
Cleavage, perfect basal	Perfect dodecahedral	Indistinct octahedral
Optically uniaxial	Isotropic	Optically anomalous?
Sectile	Brittle	Sectile

Between these there is a remarkable crystallographic relation: when a regular octahedron is considered as a rhombohedral crystal, the angle 70° 32′ corresponds to the angle 70° 36′ between the basal plane and a pyramid of iodyrite; the tetrahedrism, twinning, and sometimes the peculiar development of the miersite crystals make this relation still more striking.

Iodyrite, in all its crystallographic characters, is practically identical with wurtzite (ZnS), greenockite (CdS), and zincite (ZnO); these are all hexagonal and hemimorphic, possess a basal cleavage, and are optically positive, while the axial ratios vary only very slightly ($a : c = 1 : 0·8109 - 1 : 0·8196$). Many other substances may perhaps be included in this series, *e.g.* ice, magnesium, cadmium iodide, tridymite (SiO_2), &c. In the same way the dimorphous cubic modifications miersite, blende (ZnS), and marshite (CuI) form another parallel series, since they are all exactly alike in crystallographic characters.

It will now be seen that the same relation exists between iodyrite and miersite as exists between wurtzite and blende. This forms, as far as crystallographic characters are concerned, a perfect example of an isodimorphous group, but apparently the only relation existing between zinc sulphide and silver iodide is that their simplest conceivable chemical molecules contain two atoms.

From these somewhat remarkable relations one is inclined to ask: why should there not be a third modification of zinc sulphide to correspond with iodobromite? or why should not all these substances (*e.g.* ice, &c.) be dimorphous or trimorphous to fill up the gaps in these parallel series? Further, if nantokite and marshite are to be represented by the formulæ Cu_2Cl_2 and Cu_2I_2 respectively, then miersite should be Ag_2I_2: these double molecules, however, only depend on the vapour density of cuprous chloride, but the gaseous molecule cannot be the same as the crystal molecule, especially when there are, as in silver iodide, possibly three types of the latter.

A detailed description of miersite will be published in the *Mineralogical Magazine*. It may now be mentioned that the two specimens preserved in the British Museum collection are from the Broken Hill silver mines in New South Wales; the associated minerals on one specimen are quartz, copper glance, and garnet, and on the other, malachite, wad and anglesite. The small crystals of miersite, which do not exceed 2 mm. in diameter, are scattered over the surface of the matrix; they are of a pale or bright yellow colour, with an adamantine lustre. The only forms present are the cube and one or both of the tetrahedra, the latter usually differing in size but not in surface characters. In many respects the mineral is strikingly similar to the yellow blende which occurs in the white dolomite of the Binnenthal in Switzerland. The bright yellow streak is sometimes deeper in colour than the crystals themselves; this is strikingly shown by perfectly colourless and transparent crystals of marshite, which also give a bright yellow streak. Exposure to bright sunlight for several days does not affect the colour of the crystals. The silver is in part replaced by copper, and as this increases in amount, there is a gradual passage from miersite to marshite: "cuproiodargyrite" ($AgI.CuI$) from Chili is possibly an intermediate member of this group.

The new mineral has been named in honour of Mr. H. A. Miers, F.R.S., Professor of Mineralogy at Oxford, who first correctly determined the crystalline form of marshite, a mineral so closely resembling miersite in appearance that the two species are only to be distinguished by chemical tests.

L. J. SPENCER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Maryland Senate has passed a Bill granting 50,000 dollars a year for two years to the Johns Hopkins University.

DR. CHARLES CHREE, Superintendent of Kew Observatory, has received the honorary degree of LL.D. from the University of Aberdeen.

MR. C. B. ROUSS, who gave 25,000 dollars for a physical laboratory building in the University of Virginia, has given an additional 10,000 dollars for the same object.

MR. CHESTER W. KINGSLEY, of Cambridge, Mass., has given several large gifts to various benevolent purposes, including the sum of 25,000 dollars each to the Newton Theological Seminary, Andover Academy, and Colby University; the two first named being situated in Massachusetts, and the last in Maine.

A COURSE of eight Yates lectures in Archæology will be commenced at University College, London, on May 4, by Mr. J. Romilly Allen. The subjects of the first two lectures are the origins of primitive art and the evolution of decorative art, and the general object of the course is to trace the developments of Celtic art.

THE first school of forestry in America has just been created by the legislature of the State of New York, to be connected with Cornell University, and the sum of 10,000 dollars has been granted to cover the expenses of the first year. The school is authorised to purchase forest lands to the extent of 30,000 acres in the Adirondack region.

THE University of Paris has (says the *Times*) arranged for a loan of 1,700,000 francs from the Crédit Foncier, repayable in 50 annual instalments, for the erection of new buildings in Paris and at Fontainebleau. The Faculty of Science is also about to order the construction at a cost of 25,000 francs of an equatorial, which, after figuring in the Exhibition of 1900, will be placed in the tower of the new Sorbonne.

AT the graduation ceremony of the Glasgow University on April 12, the honorary degree of Doctor of Laws (LL.D.) was conferred upon Mr. Alexander Duncan, Secretary and Librarian to the Faculty of Physicians and Surgeons, Glasgow; Mr. Douglas Dunlop, Secretary-General to the Department of Public Instruction, Cairo, Egypt; Mr. John Inglis, formerly president of the Institution of Engineers and Shipbuilders in Scotland, president-elect of the Institution of Marine Engineers, London; Dr. Elie van Rijckevorsel, of the Batavian Society of Experimental Philosophy, Rotterdam; and Prof. J. M. Thomson, F.R.S., professor of Chemistry in King's College, London.

THE excursions of the London Geological Field Class will begin on Saturday, April 23, with a visit to Dorking, Box Hill,

and Betchworth; and between that date and the middle of July the country from Aylesbury to Cuckfield will be systematically examined by the class so as to draw a section over the trough of the Thames basin, and see the deposits to the north and south of London, which underlie the rocks associated with the chalk. The class has been organised and carried on by Prof. H. G. Seeley, F.R.S., for the past twelve years, without difficulty of any kind, and without assistance. It was established as a class to show that systematic instruction in geology could be given in the open country, and the example it affords must tend to bring about more practical teaching in the matter of field-work. When the class began there was very little of such teaching anywhere, but the value of individual observation is now accepted as a canon of scientific education, and the success of Prof. Seeley's work should encourage educationists in their endeavour to get the fact-knowledge entirely substituted for the word-knowledge of books.

SOCIETIES AND ACADEMIES

DUBLIN.

Royal Dublin Society, March 16.—Prof. G. F. Fitzgerald, F.R.S., in the chair.—Prof. J. Joly, F.R.S., and Dr. H. H. Dixon read a paper on the distribution of coccoliths and on some microscopic organisms found in Dublin and Killiney Bays. Coccoliths have been found by the authors on the Irish coast at Sligo, Slyne Head, Dingle, Waterville, and along the coast of south Co. Dublin, and on the south coast of England at Weymouth. Samples of water from Loch Inver and Portstuart did not afford any examples. Coccoliths were also found in the mud obtained in the Severn and Liffey beds. In the paper are also described a new marine Difflugia and organisms from Killiney Bay resembling Ehrenberg's Pyxidicula and Xanthidia from the chalk.—A paper by Prof. W. Noel Hartley, F.R.S., and Mr. Hugh Ramage was then read by the former, the subject being a determination of the wave-lengths of the principal lines in the spectrum of gallium, showing their identity with two lines in the solar spectrum. The authors have found gallium to be a very widely distributed element in the earth, and to be present also in meteoric bodies. It became natural to inquire if it is present in the sun. The wave-lengths of the two principal lines have not previously been determined by a grating spectrograph, and the authors availed themselves of the kind offer of Dr. Adeney to allow them to photograph spectra of gallium with the $21\frac{1}{2}$ feet radius grating spectrograph in the Physical Laboratory of the Royal University of Ireland. The two principal lines were photographed as bright and reversed lines in arc spectra, and as bright lines in the spark spectrum of a solution of gallium chloride. In these and in the oxyhydrogen spectrum of gallium compounds the less refrangible line is always stronger than the other. The wave-lengths of the two lines, determined by interpolation from adjacent iron lines, are found to be 4172·215 and 4033·125. In Rowland's map of the solar spectrum there are two lines probably identical with these, namely:—

	4172·211.	Source: Aluminium.	Intensity: 1,
and	4033·112.	Not identified.	,, 00.

It is pointed out that gallium is present in every bauxite and shale examined by the authors, and also in metallic aluminium, and no doubt the line 4172·211 in the spectrum of aluminium is really a gallium line. From the very close agreement of the wave-lengths, from the relative intensities of the lines as shown above, and from the evidence of the wide distribution of the element, it seems certain that the two gallium lines are identical with the two lines above mentioned in the solar spectrum, and there are no other lines so close to these. The evidence is discussed at length in the paper, as also is the effect of the presence of elements upon the spectra of other elements.—Prof. J. P. O'Reilly read a paper on the occurrence of anatase and brookite in the quartzites of Shankill, Co. Dublin. He explained that the minerals were found in a mass of yellow earth, met with by the quarrymen in 1888, and had only lately been examined. The peculiarity of the anatase was its approximation in composition to the clay or mineral analysed by Eakins as mentioned by Dana in his "System of Mineralogy," edition of 1892, p. 716, while presenting the crystalline form of anatase, thus allowing of the presumption that the clay analysed by Eakins and called by him "Xanthitane," was probably the product of decomposition of an anatase having much the same composition as the mineral found at Shankill.

EDINBURGH.

Royal Society, March 21.—Lord Kelvin, President, in the chair.—Lord Kelvin, in a paper on thermodynamics, deduced from motivity, fulfilled a promise made twenty-one years ago to the Society. After referring to the somewhat misleading phrase, *the mechanical equivalent of heat*, and pointing out the necessity of having a single word to express the availability of heat for transformation into useful work, he proceeded to show that the whole of thermodynamics was contained in the two equations

$$de = \mathrm{J}\mathrm{N}dt + \Sigma(\mathrm{P}dg + \mathrm{J}\mathrm{M}dg)$$
$$dm = \mathrm{J}\frac{t-\mathrm{T}}{t}\mathrm{N}dt + \Sigma\left(\mathrm{P} + \mathrm{J}\frac{t-\mathrm{T}}{t}\mathrm{M}dg\right)$$

where e is the energy, m the motivity, t the temperature of any part of the system, T the lowest temperature in the system, g any coordinate, P the corresponding force, and N, M specific heats. The usual equations are at once deduced by treating de, dm as complete differentials.—Dr. Galt, of Glasgow University, communicated a paper on the microscopical appearances of the grains in the more commonly occurring starches. The paper was full of detail, and was illustrated by numerous original photographs and lantern slides. In a paper on methods of mapping rainfall, Mr. A. J. Herbertson described a simple graphical method for taking into account the varying lengths of periods of observation of rainfall at different parts of the globe. The mean rainfall values were inserted on the maps in different coloured inks, according to the length of period of observation. The general trend of the isohyets could be attained by comparing similarly coloured means, and the final positions of the lines fixed by the values at the stations with the most extended records. The variableness in the length of the month is allowed for by drawing isohyetal lines, whose actual values are the nominal values multiplied by the days in the corresponding month, and divided by one-twelfth of a year expressed in days. In a second paper, on the normal rainfall of India and the abnormalities in 1896, Mr. Herbertson showed maps on the mean annual and monthly rainfall of India, based on the means published in the rainfall data for 1895, and those in the annual summary for 1896.

Royal Physical Society, March 16.—Mr. B. N. Peach, President, in the chair.—Papers were read by Mr. W. S. Bruce, of the Jackson-Harmsworth expedition, and Mr. William Eagle Clark, on the mammals and birds of Franz Josef Land. Mr. Bruce, who spent fifteen months on Franz Josef Land in 1896–97, explained that the number of species, exclusive of mammals and birds, he then obtained exceeded that of any previous Arctic expedition, he having secured 236 against 216 to the credit of the United States expedition of 1881–83. He had at least doubled the number of species known to Franz Josef Land. He had found ancient reindeer horns, though there were no reindeer at present in the Land. Among the specimens he exhibited were the bones of whales and walruses found on raised beaches with an elevation of from 50 to 80 feet, plainly indicating their great age; while one specimen—the scapula of a walrus—was found at a height of 336 feet. The chief point of interest in Mr. Clark's part of the subject, which was restricted to birds, was the finding of several new species—Bonaparte's sandpiper, purple sandpiper, and the shore lark. The first mentioned of these, Mr. Clark said, was not only a new and remarkable addition to the ornis of Franz Josef Land, but it was the first authentic example of this American species that had been obtained in Europe elsewhere than in the British Isles. Another subject of interest in the paper was the description of a newly-found nesting-place of the ivory gull. This was at Cape Mary Harmsworth, on what was considered to be one of the largest pieces of bare ground in Franz Josef Land. Of the twenty-two species of birds which formed the avifauna of Franz Josef Land, only ten had been found breeding, though several more undoubtedly nested there, while several, again, were mere stragglers.

PARIS.

Academy of Sciences, April 4.—M. Wolf in the chair.—On a doctrinal point in the theory of quadratic forms, by M. de Jonquières.—Contribution to the study of Zeeman's phenomenon, by MM. Henri Becquerel and H. Deslandres. An account of some experiments on the influence of a magnetic field upon the periods of vibration of the radiations emitted by incandescent vapours.—Movements of the sensitive plant when grown in water, by M. Gaston Bonnier. The author has succeeded in cultivating *Mimosa pudica* completely immersed in

water, and has studied in detail the alterations in structure and movement brought about by the new conditions of life.—On the deformation of compressed parts and the stability of large frame-works, by M. A. Bérard.—On congruences which are in several ways K congruences, by M. C. Guichard.—New expression of the elements of an orthogonal system by *theta* functions of two arguments and their application in dynamics, by M. E. Jahnke.—On a transformation of Hamilton's equation, by MM. W. Ebert and J. Perchot.—On the deformations experienced by a solid dielectric on becoming the seat of an electric field, by M. Paul Sacerdote. The phenomena in question are shown to be deducible from the principles of the conservation of energy and of electricity.—On a problem in the analytical theory of heat, by M. W. Stekloff.—On the electric conductivity of solutions of permanganate of potassium, by M. Emmanuel Legrand. The molecular conductivity increases with the dilution, and approaches the limiting value 124 obtained by former experimenters for neutral salts at 25° C.—On multiple resonance, by M. Louis Décombe.—On the thermic mercurial ampère-meter and its industrial applications: new standard of electromotive force, by M. Charles Camichel.—Comparison of the atomic weights of hydrogen, nitrogen, and carbon deduced from physical data with their values as deduced from chemical analysis, by M. Daniel Berthelot. The author claims that the calculation of atomic volumes and atomic weights from accurate determinations of the density and compressibility allows of the confirmation and, in certain cases, of the statement with precision of the results given by chemical analysis. The results obtained by various observers in the case of the three elements mentioned are criticised in detail.—Isoquinoline and tetrahydroisoquinoline, by M. Marcel Delépine. A thermo-chemical study.—On the estimation of small quantities of carbon monoxide in air and in normal blood, by M. L. de Saint-Martin. The author, in reply to the criticisms of M. Gautier, further explains the analytical modifications introduced by him. A series of experiments are described to demonstrate the presence of carbon monoxide in the blood of animals living in large towns.—On the spectrum and the nature of neodymium, by M. Eug. Demarçay.—Action of oxidising agents on some nitrogenous bodies, by M. Œchsner de Coninck. An account of the action of hypochlorites, in presence of excess of alkali, upon amines, diamines, hydrazines, cyanic and cyanuric acids, and various alkaloids.—Combination of mercuric nitrate and trimethyl carbinol, by M. G. Denigès. The author describes the preparation and properties of a new compound, which he terms mercuroso-mercuric dimethylethylenic nitrate.—On the physiology of gentianose; its hydrolysis by soluble ferments.—Detection of wood saw-dust in flour, by M. G. A. Le Roy. The suspected sample is gently warmed with an alcoholic solution of phloroglucinol, strongly acidified with phosphoric acid. The particles of saw-dust are stained an intense carmine-red colour, while the starch and cellulose of the grain itself are little, or but slightly, affected.—On the crystalline forms of the *oligist* of Puy de la Tache (Mount Dore), by M. F. Gonnard.—On the micro-organisms of "turned" wines, by MM. F. Bordas, Joulin, and de Raczkowski. The authors have isolated and studied an organism, which they propose to term *Bacillus roseus vini* from the colour assumed by its cultivations in certain media.—Effects of the solar and lunar attractions upon the atmosphere of the northern hemisphere at each of the four phases, by M. A. Poincaré.

DIARY OF SOCIETIES.

FRIDAY, APRIL 15.

MALACOLOGICAL SOCIETY, at 8.—On some New Species of Land Shells from South America: S. I. Da Costa.—Note on the Anatomy of *Resania*, Gray, and *Zenatia*, Gray: W. H. Dall.—Note on the Anatomy of *Mülleria*: M. F. Woodward.

MONDAY, APRIL 18.

SOCIETY OF ARTS, at 8.—Sources of Commercial India-rubber: Dr. D. Morris, C.M.G.

VICTORIA INSTITUTE, at 4.30.—The Design of the Human Foot: Gerard Smith.

TUESDAY, APRIL 19.

ZOOLOGICAL SOCIETY, at 8.30.—On the Breeding of the Dragonet (*Callionymus lyra*): Ernest W. L. Holt.—On the Serricorn Coleoptera of St. Vincent, Grenada, and the Grenadines, with Descriptions of New Species: Rev. H. S. Gorham.—Note on the Affinities of *Palæospondylus gunni*, Traq.: Dr. Bashford Dean.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be discussed: The Electricity Supply of London: A. H. Preece.

ROYAL VICTORIA HALL, at 8.30.—X-Rays: Bruce H. Wade.

WEDNESDAY, APRIL 20.

SOCIETY OF ARTS, at 8.—Stage Mechanism: Edwin O. Sachs.

GEOLOGICAL SOCIETY, at 8.—Note on an Ebbing and Flowing Well at Newton Nottage, in Glamorganshire: H. G. Madan.—*Petalocrinus*: F. A. Bather.—On the Origin of the Auriferous Conglomerates of the Gold Coast Colony (West Africa): T. B. F. Sam.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Anticyclonic Systems and their Movements: Major H. E. Rawson.—Results of Observations on Haze and Transparency in 1897: Hon. F. A. Rollo Russell.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—An Exhibition of Diatoms: H. Morland.—At 8.—On some Organic Substances of High Refractivity available for Mounting Specimens for Examination under the Microscope: H. G. Madan.—Instantaneous Photomicrography: E. B. Stringer.

THURSDAY, APRIL 21.

SOCIETY OF ARTS (Indian Section), at 8.—Recent Railway Policy in India: Horace Bell.

LINNEAN SOCIETY, at 8.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Cost of Generation and Distribution of Electrical Energy: R. Hammond. (Continuation of Discussion.)

CHEMICAL SOCIETY, at 8.—The Carbohydrates of Barley Straw: C. F. Cross, E. J. Bevan, and Claud Smith.—Isomeric Bornylamines: Dr. M. O. Forster.—Some Derivatives of Benzophenone: Dr. F. E. Matthews.—Researches on Camphoric Acid: Dr. S. B. Schryver.—Ballot for Election of Fellows.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Barometrical Determination of Heights: F. J. B. Cordeiro (Spon).—A Manual of General Pathology for Students and Practitioners: Dr. W. S. Lazarus-Barlow (Churchill).—Practical Radiography: A. W. Isenthal and H. S. Ward, 2nd edition (Dawbarn).—Elementary Chemistry: T. A. Cheetham (Blackie).—Synopsis Characearum Europaearum: Dr. W. Migula (Leipzig, Kummer).—Accounts of the Trade carried by Rail and River in India in the Official Year 1896–97 and the Four preceding Years (Calcutta).—Notes on Observations: S. Lupton (Macmillan).—An Elementary Course of Physics: edited by Rev. J. C. P. Aldous (Macmillan).—Essays on Museums, &c.: Sir W. H. Flower (Macmillan).

PAMPHLETS.—Some New Indo-Malayan Orchids: G. King and R. Pantling (Calcutta).—A Simple Guide to the Choice of a Photographic Lens: T. R. Dallmeyer (J. H. Dallmeyer).

SERIALS.—Knowledge, April (High Holborn).—Bulletin of the American Mathematical Society, March (N.Y., Macmillan).—Transactions of the Astronomical and Physical Society of Toronto, 1897 (Toronto).—Observatory, April (Taylor).—Atlantic Monthly, April (Gay).—Journal of the Sanitary Institute, April (Stanford).—Zeitschrift für Wissenschaftliche Zoologie, lxiii. Band, 3 Heft (Leipzig, Engelmann).—Materials for a Flora of the Malayan Peninsula: Sir G. King, No. 10 (Calcutta).—History of Mankind: F. Ratzel, translated, Part 25 (Macmillan).—Psychological Review, Monograph Supplements, Vol. 2, No. 2 (Macmillan).—Reliquary and Illustrated Archæologist, April (Bemrose).—Mind, April (Williams).

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THURSDAY, APRIL 21, 1898.

A NEW DEPARTURE BY THE RAY SOCIETY.

The Tailless Batrachians of Europe. Part i. By G. A. Boulenger, F.R.S. Pp. 210. (London: The Ray Society, 1897.)

THE publication of this elegant treatise marks an event in the history of the Ray Society upon which its members, so long content with a diet of insects, are to be heartily congratulated. Of the 210 pages of the work, 121 are devoted to an "Introduction" in which the classification, taxonomic characters, skeleton, viscera, habits, and reproduction of the Batrachia Ecaudata are successively dealt with on broad lines, special sections being added on hybrids and geographical distribution. The remaining ninety pages are devoted to a systematic treatment of the Discoglossidæ and Pelobatidæ (*i.e.* of eight of the twenty European species which the author admits), in which specific diagnoses, geographical varieties, the skeleton, habits, eggs, tadpole, and habitat, are categorically dealt with in popular but trustworthy terms. This arrangement has involved the author in an amount of repetition, but owing to the judicious placing of the seventy-seven processed drawings which adorn the work, all suspicion that this may be needless disappears, text and illustrations being found to supplement each other in accordance with a well-conceived plan. In addition, there are two maps and ten plates, six of the latter being admirable examples of the chromo-lithographer's art, of which it is praise sufficient that the author declares them to have fully satisfied his aspirations. The classification adopted is that of Cope, as emended by the author in the course of five-and-twenty years' experience, its leading feature being the grouping together of the genera *Alytes*, *Bombinator*, and *Discoglossus*, as a family (the Discoglossidæ) having well-defined and lowly affinities, which all recent investigation has confirmed. Mr. Boulenger is the foremost among the world's younger herpetologists, and in knowledge of his experience acquired during the custody of the world's greatest collection of reptiles and batrachians, of his devotion to his calling, and of his well-tried judgment, expectation ran high on the announcement of the work. It has been realised; suffice it to say that the book marks an epoch in the popularisation of zoological science, and must take its place in history beside the memorable works of Rösel von Rosenhof and Spallanzani, "Die in Deutschland lebenden Saurier" of Leydig, and others of the kind. It abounds in original observation and teems with enthusiasm, and without it no zoological library worthy the name can be complete.

The section dealing with the viscera is somewhat less satisfactory than the rest, but it is fair to the author to remark that he purposely excludes a general description of the "internal soft anatomy," and confines his attention to the "structure of the lungs and urogenital apparatus," which he regards as "of special importance from the point of view of the systematist." He in this way leads up to his morphological *tour de force*, in which (Sections 9 and 12 more particularly) he deals in an altogether masterly manner with the breeding habits and metamorphosis, earlier published papers upon which have rendered him famous. And in this connection it is particularly noteworthy that an observer of such ripe experience should pronounce against the popular ideas concerning the significance of the tadpole stage. Believing, as we do, that the conception of the frog's climbing up its own phylogenetic tree is erroneous, and that in the recognition of characters expressed in the term "derotrematous," in respect to which condition some living Batrachia are veritable fishes, far-reaching generalisations founded on the piscine resemblances of the tadpole are superfluous and have been misleading, we hail with much satisfaction the author's assertion that "larval forms such as the tadpoles are outside the cycle of recapitulation."

The only call for revision which we note is in the terminology, and that more particularly anatomical. The usage of the terms "epicoracoid" and "sternum" is regrettable, since the former, as an independent element of the shoulder-girdle, has no existence in the Batrachia, and in them the latter is known to be no derivative of the costal skeleton. "Abdominal cavity" is equally inexpressive, and the application to the vertebræ of the term "dorsal"[1] (still so barbarously retained for the thoracic of the amniota) is wrong. The description of the os cruris on one page as the "crus or tibia" and on another as the "tibia-fibula," like that of the investment of the ovum as a "gelatinous envelope" and a "sticky mucilage," is contradictory; while the reference to the fronto-parietals of *Pelobates*, on p. 35, is incomplete, by lack of insertion after "in" of the words "the adult." "Articulary balls" is amusing in its unconventionality, and "adhesive sub-buccal apparatus" is needlessly involved. The description of the so-called external type of vocal-sac as occurring in *Rana*, involving "a diverticulum of the mylo-hyoid muscle" and the said "slits at the sides of the throat," is calculated to convey a wrong impression of the facts, and error appears most seriously to have crept into the account given of the genital ducts of the males, in a manner alluded to below, for which it will be seen the author is little to blame.

The above-named are but trivial defects and unfortunate modes of expression, which in no way detract from the merits of the book. The author in his preface deplores the fact that few persons share with him a fondness for the Batrachia Ecaudata, and it must be admitted that, with the Teleostean Fishes and other groups of animals forming culminating series in definite lines of modification, these have been largely neglected by recent investigators, who, fascinated by the lowly and more generalised, have put them aside as useless in their specialisation. The study of the Teleostei is now setting these persons right on fundamentally important topics, and we claim that the remarks appended to this review justify the assertion that in the study of the despised Anura there lies the settlement of that which is to-day one of the most vexed questions concerning the genital ducts of the vertebrata. And tempted thus to speculate

[1] "Presacral" is the only term by which these can be accurately described in the Batrachia.

upon what remains to be ascertained about mere frogs and toads, the mind reverts to their mechanism of accommodation for vision within and without the water, our knowledge concerning which is an absolute blank. If we may judge by analogy to the inanimate, displacement of the lens of an altogether remarkable order must take place, and there is thus opened up a line of investigation of absorbing interest alike in its morphological, physiological, and physical aspects, in which, to say the least, there probably lies the explanation of the remarkable series of accessory eye-muscles which these animals possess.

That a great deal remains to be done in the study of these familiar creatures is certain. The author has produced a masterly treatise upon their classification and distribution, upon which he is now a leading authority. He deals with a subject historically associated in a prominent manner with the labours of English-speaking zoologists, and tells us that he will be content if those who use the book may derive from the perusal of its pages one-tenth of the pleasure it has given him to write them. His preface, in which this sentiment occurs, is positively infectious in its enthusiasm, force of personal example, and love of science for its own sake; and neither he nor we could desire more of his book than that it might stimulate to action some one who should in turn succeed him as a foremost authority upon the group of animals with which it deals.

Concerning the vestigial portions of the urinogenital apparatus above referred to, the author, relying only upon macroscopic characters and following Spengel, has described the duct which in *Alytes* receives the vasa efferentia as Müllerian; and he regards the vesicula seminalis in all forms as a derivative of that. He omits mention, however, of the vestigial Müllerian duct of the male *Rana*, which, though exceedingly delicate, is usually present; and this is the more regrettable since Marshall proved microscopically that it skirts the outer border of the vesicula as an independent tube. The relationships of the vesicula to the so-called "ureter" in *Rana*, and to the presumed Müllerian duct in *Alytes*, the alleged homology of which has been challenged, are thus seen to be identical, wherefore the latter would appear to represent the Wolffian duct proper, and the so-called "ureter" of the Anura either a specialised portion of that, or an independent duct arising from the kidney, as might well be from the condition in *Alytes* and some Urodela. Comparative embryologists will not need to be reminded that a precisely similar difficulty besets the interpretation of the corresponding parts in the Elasmobranch fishes, and as concerning the Anura more particularly the whole matter, anomalous to an unparalleled degree on the Spengelian interpretation, apparently harmonious and exceptionally instructive by extension of Marshall's observation, demands renewed microscopic inquiry. Indeed, to the present writer it has long appeared that the male genitalia of *Alytes* and *Discoglossus*, as here interpreted, conform to a type transitional between that of the Urodela in which a fully-developed Wolffian body, differentiated into a sexual and a renal portion, is present, and of the higher Anura, in which the homologue of the renal part receives the vasa efferentia, and to justify the conclusion that the latter condition is secondary and associated with the suppression of the sexual part. And if this be so, an additional argument will have been furnished for the lowly affinities of the Discoglossidæ.

G. B. H.

PREHISTORIC CIVILISATION IN EGYPT.

Recherches sur les Origines de l'Égypte. Ethnographie Préhistorique et Tombeau Royal de Négadah. Par J. de Morgan. Avec la collaboration de MM. Wiedemann, Jéquier, et Fouquet. Pp. x + 395. (Paris: Leroux, 1897.)

THE large section of the scientific public which is interested in prehistoric remains will, we are sure, cordially welcome the second part of M. de Morgan's work on "Les Origines de l'Égypte," which is now before us. Every reader of the first part waited, we fear with some impatience, for the supplementary facts which were known to be forthcoming; and now that they are in our hands, it is more possible to judge of the general effect of M. de Morgan's recent discoveries upon the sciences of archæology and anthropology. For some years past the natives of Upper Egypt have been offering numbers of curious objects for purchase to the tourist and wandering Egyptologist, and the said objects were so remarkable from artistic and other points of view, that more than one archæologist have pronounced them to be forgeries. That these objects came from several different places in Upper Egypt was quite certain, but it was hard to believe the fact, and most people, whatever they said, privately thought the statements of the natives to be unbelievable.

M. de Morgan was the first to find the solution of the difficulty, and now he has triumphantly proved that these strange objects do really come from a number of sites which extend along the Nile Valley from Cairo on the north to Wady Halfa on the south, and that they represent the remains of a people who occupied Egypt before the Egyptians who have hitherto been known to us from inscribed statues, temples, &c. In the second chapter of the present volume of his work he gives a list of these sites, and it may be considered the most important section of his book; it is much to be hoped that now circumstances have obliged him to transfer the field of his labours to Persia, others, whether they be English or French, may take steps to examine by means of systematic excavations the sites of which he has given us such a full list.

But though M. de Morgan has not been alone in making researches concerning the history of the remote period in which these sites were occupied, and though Messrs. Petrie and Amélineau have collected much information from their excavations at Amrah, Ballas, and Nakada, it must not for one moment be imagined that all the questions connected with the prehistoric people of Egypt can be answered, or all difficulties solved. Nor can it be said whence this people came, or when they first occupied their stations in the Nile Valley; at present it is difficult even to find a name for them which will satisfy both M. de Morgan and Mr. Petrie. M. de Morgan, basing his opinion upon anthropological evidence

adduced by Dr. Fouquet, as much as upon the archæological evidence which he himself has carefully sifted, has come to the conclusion that the people whose remains he has found are as old as any race known in the world, and that, in any case, they are the earliest inhabitants of Egypt. On the other hand, Mr. Petrie calls them the "New Race," which appellation, viewed in the light of the evidence given in M. de Morgan's book, is clearly wrong, and shows that Mr. Petrie did not understand the facts of the case.

According to M. de Morgan the word "Egyptian" signifies the man who migrated from Asia to Egypt, whose civilisation was peculiar to himself, and whose ethnic history is still unknown. Between him and his predecessor, whom we may call the aboriginal inhabitant, he draws a sharp distinction both mentally and morally, and the former was mesaticephalic and the latter dolichocephalic. It is important to note that the *indigènes* had smooth and fair hair, and that they belonged to the white race; thus the old theory that the Egyptians were of negro origin receives another blow, and incidentally it is quite clear that the Cush referred to in the Bible as the home of the Egyptian is not Ethiopia. In the chapter on the indigenous peoples of Egypt we have a most useful account of the various objects which have been found in the prehistoric sites, well illustrated by scores of woodcuts which will prove invaluable to those who have not the opportunity of studying the originals, and at the end is given a good account of the various methods of burial employed by the *indigènes* of Egypt.

In the earliest times the dead were buried without any attempt being made to mummify the body or to strip the bones of their flesh. Later, the flesh was stripped from the bones, which were then buried, frequently in great disorder; sometimes the body was simply hacked in pieces so that it might be packed easily in a small space. Still later, an attempt to preserve the body by mummification was made; for Dr. Fouquet has found traces of bitumen in the bones which he has examined. In the earliest tombs no metal objects have been found, but of those in which no instruments of iron and bronze have been discovered, the famous tomb at Nakada which M. de Morgan first excavated, and has described in the fourth chapter, is the best known example. It is, of course, quite easy to see from the remains of offerings found in the prehistoric tombs that the belief in a future life of those who made them was both well established and widely known. And if they believed in a future life it seems that they must of necessity have believed in a divine power, and to have the superstitions which take the place of religion among early peoples. The abominable practice of cannibalism which Mr. Petrie attributed to his "New Race," finds no support in the account which M. de Morgan has given of this people, and we agree with Dr. Verneau, who in discussing this subject says—

"Les faits allégués à l'appui de cette assertion s'expliqueraient tout aussi bien si l'on admettait simplement un décharnement à l'air libre, précédant l'ensevelissement définitif."

Mr. Petrie's sensational discovery therefore falls to the ground.

Space will not allow us to discuss the objects which M. de Morgan found in the tomb of Nakada, much less to refer to the interesting deductions made by M. Wiedemann from them; it must suffice to say that quite new light is thrown upon many well-known facts, and that many of our preconceived notions must be abandoned. Of special interest to the anthropologist is Dr Fouquet's minute description of the skulls of the *indigènes* of Egypt; the careful measurements, too, will be invaluable to him. Neither M. de Morgan nor Dr. Fouquet attempts to assign a date to the occupation of the land of Egypt by this people, and no guess is made at the length of its duration.

Though M. de Morgan's last work does much to settle the difficulties which his own discoveries have raised, many questions must, we fear, for some time remain open. But to him all students owe a big debt of gratitude, both for the careful way in which he has collected and stated his facts, and for the zeal with which he carried out his excavations; his work is of peculiar value from the fact that he never forgets his task as an expounder of facts so far as to become an advocate. The mere Egyptologist would have misread the evidence of the prehistoric graves because he never takes the trouble to realise that a good Egyptologist is not necessarily a good archæologist, and we must be thankful that for once the right work fell into the right hands. All will, however, regret that the French Government has removed M. de Morgan from Egypt to Persia, especially as they did so at the time when he was doing his best work.

A COUNTY FLORA.

The Flora of Berkshire. By George Claridge Druce. Pp. cxcix + 644. (Oxford: Clarendon Press, 1897.) [Published 1898.]

THIS volume is worth a review, for it has merits found in but few "Floras," and failings common to many.

In 1886 Mr. Druce published "A Flora of Oxfordshire"—a flora, except for the inclusion of some account of the lower plants, of the very ordinary type. In his second flora, while omitting the lower plants except *Characeæ*, he introduces in his critical notes on species a new feature. Every variation has a claim on the botanist's attention; and where can local varieties be better considered than in a local flora? It is a good feature in the book. And, further, the mania for names or for giving prominence to names does not offend. The varieties are usually mentioned in these notes in a way which gives an appearance of proportion to the enumeration, and so do not appear—undefinable gradations as they often are—in series like so many milestones along the road.

A county flora must always be considered from the dictionary standard. The main body is of necessity a work of reference. Viewed in this light, we find in the "Flora of Berkshire" merits and demerits. The division of the county into geographical areas is satisfactory, much more so than in the "Flora of Oxfordshire," where they are very unequal. In a level region, such as that of our Midland counties, there are no natural areas,

unless they be made by the soil. To follow the outlines of the various formations, as Babington well did in his "Flora of Cambridgeshire," would for Berkshire be a difficult task; and Mr. Druce may not have done amiss in defining his regions by drainage. The result of his division is that every region contains some chalk, and consequently some of its characteristic vegetation.

An original dictionary is aggravating; and Mr. Druce is unwise in choosing, by his changes in nomenclature, to publish such. Of all places, except perhaps a seedsman's catalogue, such alterations could not be more out of place. And when he selects to give *Potamogeton* two genders he becomes pedantic. To expect a man with more common sense than leisure to inquire before writing the name of a species of this genus whether its author made it masculine or neuter, is to proffer him a fetter of a nature as galling as purposeless. It may be safely said that this is a demerit possessed by no other English county flora.

In the next place, a county flora must be considered as a geographical study. Great pains are usually taken to get together accurate facts (and this flora is no exception); but the builder tips up his bricks and mortar at your door, leaving the building to your own architectural fancy. As long ago as 1863, in Baker's "North Yorkshire," an admirable model was set, but no one has followed in the same lines. Mr. Druce in the introduction gives a long description of his districts, and long lists of the noteworthy plants, but in the summary he fails to point out any connection between these; he points out the soils of the county well—perhaps not so well as in Pryor's "Hertfordshire Flora"—but fails to summarise their effects on the plant formations; he has pointed out the deforesting of the land, but hardly notices its effects; and he has given us agricultural returns, and passes unnoticed the effects of agriculture. Surely such things should be the crowning of such a book—a bringing into one view the long arrays of facts which have gone before. It is a fault of most floras that they are wanting in this.

This "Flora of Berkshire" forms a thick volume of more than 800 pages; and it is not free from irrelevant remarks. For instance, the fossil shells of the Lower Greensand (p. xxxi) have no bearing on the subject; the history of the "Imp" stone (p. xlii) is out of place; most of the matter on river drainage (pp. xlvii–liii) is of little use; to be informed that the late M. A. Lawson compiled a MS. index to Jaeger's "Adumbratio" (p. clxxvii) is not of interest, and but poor salve to one who needs use those two cumbersome volumes; nor does it in the least benefit us to be told that Mr. Druce has been unable to elicit any reply from certain critical botanists.

Caution, too, is sometimes left behind. That *Elodea* is dying out by reason of the absence of the ♂ plant (p. 465) is merely a conjecture. A little knowledge of recent literature should have shown that *Nepeta Glechoma* var. *parviflora* (p. 402) is merely a condition. In fact, Mr. Druce's "Flora of Berkshire," founded on so much labour, deserved a careful revision before it went to press, and did not get it. It may rank with our best county floras in some ways; but most of these are far from approaching a high scientific standard. There is a tendency now to aim at more ambitious works than catalogues of "Phanerogams." The comprehensiveness of Purchas and Ley's "Flora of Herefordshire," the notice of the past vegetation of the peat in Hind's "Flora of Suffolk," the scattered biological notes of Scott-Elliot's "Flora of Dumfriesshire," and the critical remarks of Druce's "Flora of Berkshire" are good signs, which we hope may lead to better things.

I. H. B.

AMONG THE ISLANDS OF THE PACIFIC.

Wild Life in Southern Seas. By Louis Becke. Crown 8vo. Pp. viii + 369. (London: T. Fisher Unwin. 1897.)

THE author of "Pacific Tales" and "By Reef and Palm" stands in no need of introduction either to the reader of fiction, or to the more serious-minded who seek for information upon a part of the world where the "personally-conducted" tour is as yet unknown. Mr. Becke, in virtue of his twenty-six years of wandering among the islands of the Pacific, has made himself an acknowledged authority upon most of them, from the Carolines to the Paumotus, and now that Major Sterndale is no longer with us, is probably better qualified to speak of this region as a whole than any person now living, though there are doubtless others whose knowledge of individual groups is more extensive. The volume before us is upon the same lines as "By Reef and Palm," a collection of reminiscences *per ci per là*, rather less full of deeds of bloodshed, perhaps, than the latter volume, and containing more of interest to the naturalist and ethnologist, but at the same time possibly not devoid of fiction, or at least of fact and fiction commingled. Some of the articles seem familiar to us; one at least, upon *Birgus latro*, has appeared in the columns of the *Field*.

The volume is one which will appeal especially to the sea-fisherman who has tasted of the delights of reef-fishing in Pacific waters, for half a dozen or more of the articles are devoted to this sport in one shape or another. The abundance of fish is not less remarkable than their variety. Mr. Becke tells us that in the Ellice group he has seen as many as twenty canoes loaded to sinking point in less than an hour; while, as for size, the *takuo*, a large species of albacore, reaches the weight of 120 lb. and more. Shark-fishing is no very novel amusement, perhaps, but catching flying-fish is a sport not so widely practised, and Mr. Becke's description of it is a vivid one. He has also done well in putting together his sketch of the history of whaling in the South Seas.

No new light is thrown upon the curious stone buildings and fortifications which exist over the length and breadth of the South Pacific, and have for so long puzzled archæologists, though Mr. Becke speaks of what are probably the most extensive of all—those on Espiritu Santo. Some interesting facts concerning population are given. It has now been known for some time that the extinction of these island peoples in consequence of the advent of the whites, formerly regarded as an immediate certainty, is not only not impending, but is never likely to occur, except by the process of fusion—that the census minimum has been reached, and that steady increase is the rule rather than the exception. Funafuti, the island lately visited by the coral-boring expedition, is a good

example of this. About sixty or seventy years ago its population was estimated at 3000; in 1870 Mr. Becke counted only 160; and now it is said that there are over 500 inhabitants. Nanomaga, too, can scarcely be quoted as an example of the extinction of the native, for here, in an area of a square mile, we find a population of more than 600—a density only equalled by that of some of the islands of the neighbouring Gilbert group. It is to be hoped that the author of "Wild Life in Southern Seas" may some day put his knowledge of the islands into more regular and scientific form. F. H. H. G.

OUR BOOK SHELF.

Mediterranean, Malta, or Undulant Fever. By M. Louis Hughes, Surgeon-Captain Army Medical Staff. Pp. xi + 232; figs. iv.; tables xv.; charts xx. (London: Macmillan and Co., Ltd., 1897.)

THE book before us is an exhaustive monograph upon an apparently, up to the present, neglected variety of continued fever, viz. Mediterranean or Malta fever. The author, at the beginning of the monograph, gives reasons why this fever should be regarded as a definite specific disease—distinct, on the one hand, from malarial and, on the other, from enteric fever, and suggests that it should in future receive the name of undulant fever. The term Mediterranean, Gibraltar, or Malta fever is, according to him, misleading, as apparently ascribing to the disease a geographical limitation which it does not possess.

In Chapter ii. a discussion will be found of the bacteriology of the disease. The author's observations, so far as the presence of a definite micro-organism, and the artificial production of the fever in monkeys are concerned, confirm Bruce's earlier results. Chapter iii. is devoted to symptomatology, and concludes with a description of the usual complications and sequelæ. In Chapter iv. the author discusses fully differential diagnosis, prognosis, and morbid anatomy. The final chapter is devoted to the consideration of prophylaxis and treatment. Two good indices conclude the volume.

The work will doubtless be of great service to those who are engaged in military or civil practice at Gibraltar or Malta, and must further be regarded as a valuable addition to the literature of continued fevers.

F. W. T.

Lehrbuch der Vergleichenden Mikroskopischen Anatomie der Wirbelthiere. Zweite Teil, Schlund und Darm. Von. Dr. Med. Alb. Oppel, a. o. Professor an der Universität Freiberg i.B. Pp. 681, with Plates. (Jena: Gustav Fischer, 1897.)

THIS volume is a worthy successor to its predecessor on "The Stomach," published in 1896, and we have nought but praise for it. At first sight it would appear well-nigh impossible that two such works could be successfully compiled in so short a time; but there is internal evidence that the book bears a direct relationship to a series of papers which its author has published during the last eight years, and that its preparation has been a prolonged labour of love. The present volume opens with a dissertation upon the structural plan of the alimentary canal and its derivatives, extending to thirty-one pages; and in the rest of the book the ordinarily recognised regions of the intestine, and the œsophagus, are successively dealt with in an exhaustive manner, structure and function being alike considered. The work closes with a 36-page alphabetical record of literature arranged according to authors' names. The mode of treatment of the subject, like that of the preceding volume on the stomach, is thoroughly systematic and logical; and while the pages of the book bristle with references to original authorities, its style is nowhere pedantic. Though termed a text-book, it is an exhaustive work of reference such as we believe the advanced scientific text-book of the future must become. There are 343 admirable text illustrations and four exquisite plates, well worthy the text and the immense labour its author has bestowed upon it. We note one or two omissions, as, for example, of all mention of the intestinal valve in the Teleostei (*Cheirocentrus*) and of Huxley and Parker's observations upon the cœcal and colic valves of *Lepus*. The fuller paper by Laguesse might have been referred to, as might the observations of Mazza and Perugia upon the rectal glands of *Chimæra* and other matters which could be mentioned. All that is really important, however, is recognised. The work fills a gap in our literature, and to its author students and teachers stand alike indebted for a masterly treatise which will long remain the standard book of reference upon the subject with which it deals.

Spectrum Analysis. By John Landauer, LL.D. Authorised English edition by J. B. Tingle, Ph.D., F.C.S. Pp. 239 + x. (New York: Wiley and Sons. London: Chapman and Hall, 1898.)

THAT there is a real need for a fairly comprehensive text-book of spectrum analysis of moderate size will be acknowledged by all who have occasion to teach the principles of the subject, or to employ its methods for analytical purposes. To meet this need appears to be the object of the book before us, though it does not claim to be exhaustive. The treatment of the subject is historical throughout, and there is a great number of useful references to important memoirs, while particulars of the spectra of elements and compounds occupy nearly one-third of the volume. As a general text-book of the subject, apart from its astronomical applications, the book has much to recommend it; but it leaves a great deal to be desired as a guide to the practical details of spectroscopic work, which, as the translator remarks, "furnishes so many opportunities for an excellent training in accuracy of observation and manipulative skill." The lack of the practical touch is frequently indicated. In the table of magnesium lines (p. 143), for example, the lines of the arc and spark spectrum are grouped together, and the omission of the most striking line of the latter at λ 4481, possibly for the reason that it is all but invisible in the arc, might cause much loss of time to a student who happened to observe this line and attempt to ascertain its origin. Again, there are no instructions for photographing spectra, although in the majority of cases this is by far the best method to adopt in practice. Least satisfactory of all, the whole subject of comparing observed with tabulated spectra is far too cursorily dealt with to be of real value to the practical student.

In various theoretical matters, such as the relationship of the lines of an element to each other, the subject-matter is well up to date; but, as already hinted, the astronomical applications are scarcely touched upon.

The illustrations call for little remark. Most of them are well-worn, and we especially regret that the author has seen fit to prolong the life of the feeble map of the solar spectrum on p. 187, which so inadequately represents Fraunhofer's beautiful original.

Tabellarische Uebersicht der Mineralien nach ihren krystallographisch-chemischen Beziehungen geordnet. Vierte Auflage. By P. Groth. (Braunschweig, 1898.)

THE fourth edition of the well-known tables of the Munich Professor closely resembles its predecessor in appearance and in general character, but has in reality been considerably modified. Each well-define d mineral group is now introduced by a general discussion of the chemical

and crystallographic relationships, in place of the notes appended to each group in the earlier editions; and the crystal class to which each mineral belongs is defined. Thus the book, while preserving the form which is now so familiar to every student of mineralogy, is in reality much more of a treatise on mineral chemistry than it was before. In fact, it may be regarded as the most useful text-book on this subject available for a student. The researches of Penfield and of Clarke have thrown a flood of new light upon the chemistry of minerals, and Prof. Groth is, as is well known, never slow to incorporate the latest results of science in his books.

These tables are indispensable to the student, and of immense use to the systematic mineralogist: to the latter especially in those passages which express the critical views of an author of unrivalled experience and judgment upon minerals of obscure composition.

The following examples, chosen almost at random, will suffice to illustrate the modifications which have been introduced into the old classification. Pyrrhotite is now FeS, and is placed in the Wurtzite group; Lorandite, the new sulpharsenite of thallium, is placed with Miargyrite; Ilmenite has been removed from the Hæmatite group of oxides, and is classed with Pyrophanite as a titanate of iron, in consequence of recent observations by Penfield.

But it is needless to multiply examples. The book should be the handy companion of every mineralogist. It is only necessary that in this, as in former editions, the reader should bear in mind that rational formulæ in mineralogy are never free from the taint of speculation.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Sub-Oceanic Terraces and River Valleys of the Bay of Biscay.

WILL you allow me to add to my communication, which appeared in NATURE of March 24, regarding the results of investigations carried out by means of the Admiralty charts beyond the coast of the British Isles, a still further statement regarding the Bay of Biscay? The results are not less remarkable and suggestive of great changes of level than are those indicated by the soundings to the west of the British Isles, which I hope to describe in full at the meeting of the Victoria Institute on May 2. We have the same general physical contours: first, the Continental shelf, or platform, stretching out for a distance of over 100 miles along the northern edge of the bay, but narrowing southwards till along the coast of Spain it contracts to an average breadth of twenty to thirty miles. At its outer margin the shelf breaks off at the 200-fathom line in a grand escarpment, continuous with that of the British platform, and descending with a more or less steep descent to somewhat over the 1200-fathom line. Off Cape Ortegal the escarpment is almost precipitous, for the total descent of 7000–8000 feet is effected within a horizontal space of about four miles; from the base of the escarpment the ocean-floor, formed of calcareous ooze, stretches gradually away to depths of 2600 fathoms and upwards. The escarpment forms the natural boundary between the region of *Globigerina* ooze and the Continental platform of sand, mud and gravel with shells.

Lastly, the old channels of several of the river valleys can be distinctly traced when they approach and intersect the grand escarpment. This is remarkably so in the case of the Loire, the Adour, the Las Cubas and Caneiro rivers. The Adour passes out to the deep ocean through a continuous deep cañon or gorge of 100 miles in length—marked on the Admiralty chart at its upper end as "Fosse de Cap Breton." At a distance of thirty miles from the coast the bed of the cañon is about 3174 feet below the general level of the Continental shelf, and at a distance of sixty-two miles it descends to a depth of about 5442 feet below the same level. The cañon itself can be distinctly traced to the depth of 9000 feet (1500 fathoms), where it opens out on the oceanic floor, representing the feature known by American geologists as "the base-level of erosion"—in other words the limiting depth of river-erosion at the time when the land was elevated, and indicating the extent of the elevation as compared with the ocean level of the present day. The "embayments" of the other rivers mentioned can be traced to about the 1200-fathom contour. Such concurrence of evidence as regards the great up-lift, presumably reaching its maximum at the commencement of the Glacial Epoch, is conclusive in its testimony. The British and Continental platform was probably referable to the Mio-pliocene period. EDWARD HULL.

April 19.

Dust Fog in the Canaries.

IN amplification of the notice published in NATURE concerning the dust shower encountered by the *Roslyn Castle* off the west coast of Africa, I have the honour of sending you the following description of the phenomenon as experienced in the city of Laguna (Teneriffe), that I have received from Prof. Calvo, keeper of the Meteorological Station. I send also a summary of the meteorological register.

AUGUSTO ARCIMIS.

Instituto Central Meteorológico, Madrid, April 14.

From the first hours of the evening of February 15, there was observed a sensible but light fog; neither the strength of the wind (E. gentle breeze) nor any other phenomenon indicated that the supposed condensed vapours could be African dust transported by the air. As the night advanced, the force of the wind increased, until it reached the value of a moderate gale. At about 5 a.m. on the 16th, some large drops of rain fell, but were inappreciable in the rain gauge. For a very short time the wind subsided, by and by becoming again a gentle breeze during the day and blowing due E. The fog became more dense, causing depression and a disagreeable feeling produced by its dryness. The sun, on account of its light being pale and feeble without the usual rays, was confounded with the moon; and it reminded one of the light of a voltaic arc seen through a frosted glass. The flame of a match appeared with a very marked violet hue. The drinking waters became salty and coloured as by oxide of iron. The dust was grey and extremely fine, and deposited itself on every object.

On February 19, from the early morning the sky was again clear and transparent, and the wind was blowing from the N. and N.W.

Meteorological Observations taken at Laguna (*Teneriffe*), *during the Dust Fog, in February* 1898.

Feb.	Hours.	Barometer at 0° and sea level.	Thermometer (Dry).	Thermometer (Wet).	Humidity.	Evaporation.	Maximum thermometer.	Minimum thermometer.	Wind. Direction.	Wind. Force.	Sky.
					%						
11	9	766·2	14·3	11·0	66				N.	3	Blue
	3	764·5	21·0	15·0	49	1·5	21·2	6·0	S.	3	,,
12	9	766·1	20·0	12·7	38				N.	3	,,
	3	765·5	17·7	13·8	63	2·1	19·5	6·5	N.	3	Cloudy
13	9	766·9	14·3	12·0	75				N.	3	,,
	3	765·9	16·2	13·5	73	2·6	18·3	10·0	N.	3	,,
14	9	767·1	14·3	12·0	75				N.E.	3	,,
	3	764·7	15·7	13·0	72	1·8	19·0	9·0	E.	3	,,
15	9	765·4	14·4	10·3	56				E.	4	Overcast and foggy
	3	762·7	16·0	13·0	69	2·1	17·3	9·0	E.	7	,,
16	9	761·6	14·3	9·6	51				E.	4	,,
	3	760·2	16·3	12·0	57	2·4	17·8	10·0	S.E.	3	,,
17	9	763·2	14·0	10·7	61				E.	3	,,
	3	761·4	14·0	12·0	78	2·1	19·0	9·8	S.	3	,,
18	9	763·3	13·8	12·3	83				N.	3	Cloudy
	3	762·5	14·0	12·0	78	1·1	14·8	8·0	N.W.	3	,,
19	9	764·0	13·0	11·0	77				N.	1	,,
	3	763·0	14·0	12·8	86	1·1	15·0	9·0	N.	3	,,
20	9	765·1	12·8	10·2	70				N.	3	,,
	3	763·5	16·8	12·5	58	2·2	18·0	8·2	N.	3	,,

THE PHLEGRÆAN FIELDS.

THE fired rocks and hills of volcanic origin stand in so striking a contrast to those of aqueous origin, that they have exercised a very powerful influence on the thoughts of man in all ages. Frequently associated with such formations are the phenomena which we are accustomed to refer to as volcanic—"burning mountains," boiling springs, gaseous exhalations, terrifying noises—all shrouded with a mystery which demands explanation. Even in a locality in which the volcanic fires have been extinguished or have long remained quiescent, the peculiar configuration of the ground often keeps alive the tradition of former outbursts of subterranean fire, and the tradition usually supplies the explanation of the configuration. The ancient Romans, long before the awful catastrophe of A.D. 79, seem to have been quite aware that Vesuvius had not always been in a condition to support the rich cultivation which covered its slopes in their day. It is only in rare cases that the inquirer is rewarded by finding that the history of a heap of burnt soil is preserved; more often he will hear vague stories of the direful effects of prehistoric struggles of Cyclops or other mythological monsters.

In a recent research[1] I have endeavoured, by examining the marks with which the Phlegræan Fields are scored, like a much over-written palimpsest, to collect materials for a history of the alterations which the surface of the country has undergone. Within the Phlegræan Fields, west of Naples, only two volcanic structures have been formed within the historical period. For trustworthy information respecting all structures but the Monte Nuovo and the lava stream from the Solfatara we are entirely dependent upon the facts collected by the geologist and the geographer. In my work I was chiefly guided by the desire of estimating how far the existing superficial configuration or morphography of a volcanic region is an indication of the past history of its development. With this end in view purely topographical features, selected according to certain principles, were studied, and from them a theory of their origin and relative age was constructed. The results obtained by the method admit of being tested by the results of geological research whenever the latter is possible.

The importance of a method which will yield information respecting the past history of a volcanic country from a mere superficial examination is very considerable. The volcanic regions of the sea-bottom and of the moon are alike inaccessible to the stratigraphical geologist. The only kind of information obtainable is that respecting the superficial configuration; and therefore it is of the greatest importance that the value of a method which will enable us to utilise this information, in reading the records of the past, should be carefully estimated by experiment within the sphere of the geological critic.

The Phlegræan Fields are well suited for the trial of such a method, because within a small area the face of the country records the results of long-continued volcanic activity and of denudation both by sea and rain. Within an area of not much more than fifty square miles are collected the assemblage of volcanic vents and crater walls, the presence of which distinguishes the Campi Flegrei from the adjoining level plains of fertile volcanic soil of the Campagna Felice, stretching right away inland to the limestone slopes of the Apennines.

By far the most important topographical features within this region are composed of loose ashes or of compacted tufa. Lava-streams or heaps of lava characteristic of so many other volcanic regions cover but a small part of the surface of the country at the present day; in the future, no doubt, their harder, more resistent qualities will cause them to stand more prominent when the forces of denudation have removed the superincumbent layers of more readily erosible tufa.

Many of the hill forms are readily reducible to the simple type of a volcanic crater wall surrounding a crater, such as is naturally formed by fragmentary materials ejected from a vent and allowed to fall uniformly around that vent. In the Phlegræan Fields there are five almost perfect examples of such volcanic ring walls. Of these, Monte Nuovo is still to be seen in much the same condition as it was immediately after its eruption in September 1538. The Fossa Lupara, Solfatara, Astroni and Cigliano are hardly less perfect examples of typical volcanic craters. The topographical aspect of all is identical. In each a crater is entirely surrounded by an almost circular wall, which has a steep and sometimes precipitous crater-slope on the inside, but a more gradually inclined cone-slope on the outside.

Fig. 1.—Crater of Astroni from the North-East. In the distance is part of the crater wall of Archiagnano culminating in the Torre Nocera.

In addition to these hills, which are volcanic cones of the first rank of symmetry and preservation, there are others which are not less certainly volcanic cones produced in the same way, but which have had their symmetry marred by the removal of their flanks, either by marine erosion or by destructive eruption from an adjacent volcanic vent. The walls of the craters of Capo Miseno, Porto Miseno, Bacoli, Campiglione and Nisida, have all been more or less removed on the side turned towards the sea, and, with the exception of the Campiglione crater wall, are still being eroded away at the present time. The craters of Porto Miseno and Nisida are submerged, and being in communication with the open sea by breaches in their walls, afford good harbours for small vessels. The floors of the other craters are above sea-level. On the other hand, the

[1] "The Phlegræan Fields." By R. T. Günther. (*Geographical Journal*, 1897, vol. x. pp. 412–435, and 477–499, with 8 maps and 15 figures.)

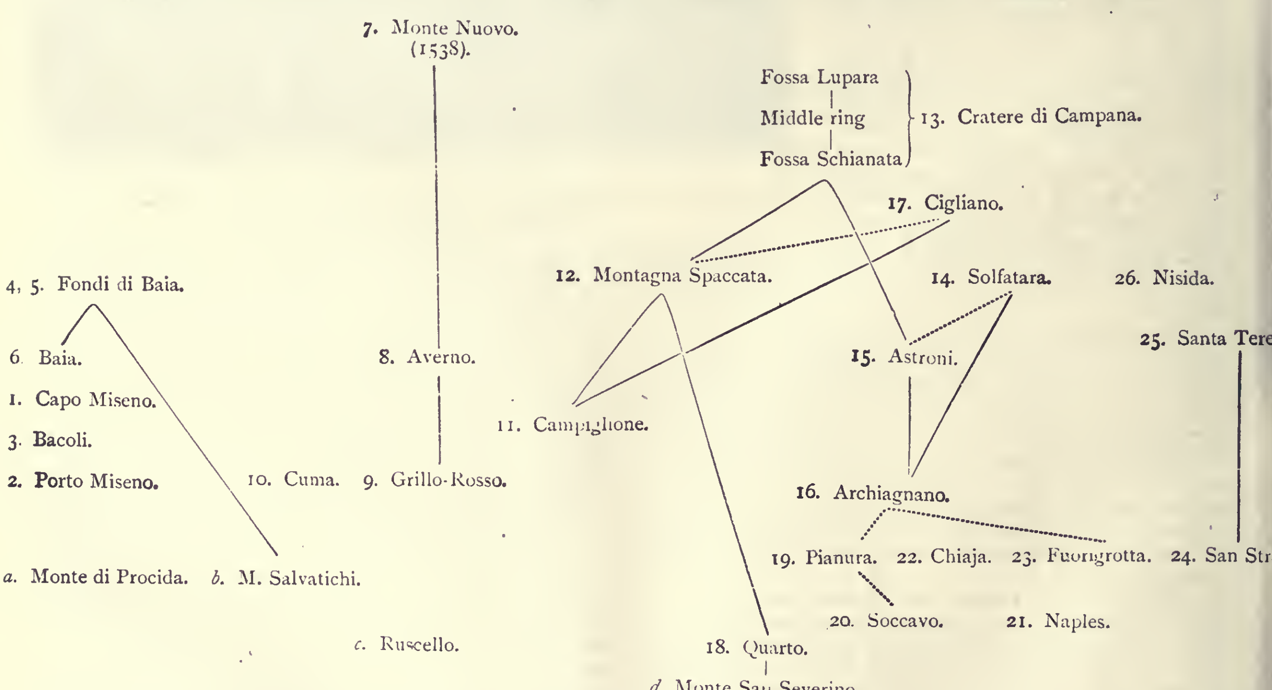
crater walls of the Fondi di Baia, Lago d'Averno, and the two outer crater rings of the Cratere di Campana, have been partially obliterated by outbursts from other volcanic vents on or near their periphery.

Fig. 2.—Capo Miseno from the Northern side of Porto Miseno.

In all these cases of partially destroyed crater walls, their shape on the whole agrees very well with that of the five perfect crater walls enumerated above, and with the generalised type of a volcanic cone composed of fragmentary materials. In fact, there seems little reason to doubt their origin as segments of volcanic crater walls.

Passing now from the hills which bear a more perfect resemblance to a typical crater wall to those in which the resemblance is less perfect, I have been led to adopt the following criteria as indications: firstly, of whether a hill can be regarded as a segment of a volcanic crater wall or not; and, secondly, of the position of the volcanic crater.

Table showing supposed Chronological Order of Formation of Volcanoes of Phlegræan Fields.



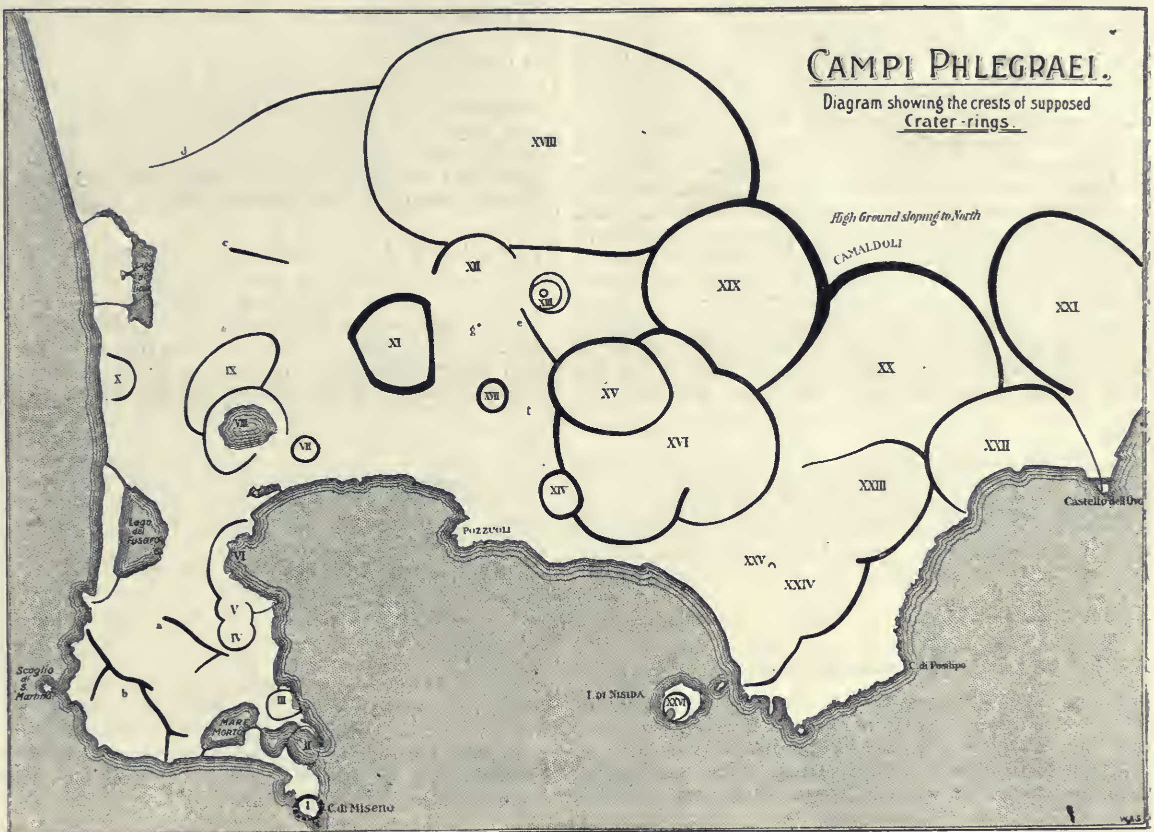
(1) If a hill is convex towards one side and concave towards the other, it is assumed that the crater which it formerly surrounded was situated on the concave side; and the radius of the crater at any level is indicated by the radius of the arc formed by the horizontal projection of the horizontal curve of the crater slope at the same level.

(2) A further indication of position is afforded by the fact that in almost every case the natural crater slope is much steeper than the corresponding cone slope.

(3) If arc-shaped hills be so situated that a curve approaching a circle can be drawn so as to pass along all their ridges, it is an indication that the hills are parts of one and the same crater wall.

to have once formed part of the walls of volcanic craters whose position is sufficiently well-indicated by the criteria enumerated above, are shown in the accompanying map. The map was constructed by drawing lines along the highest ridges of the hills enclosing undoubted volcanic craters, and then along those of less certain origin. The lines were then thickened according to a definite scale in which the breadth of line was made proportional to the height of the hill above sea-level. The highest hills in the north-east are over 1500 feet above sea-level, and are represented by the broadest lines.

One of the most striking features brought out in this map is that several of the crater-ring walls end abruptly in the circumference of others. Where this is the case



EXPLANATION OF MAP.

I. Capo Miseno
II. Porto Miseno
III. Bacoli
IV., V. Fondi di Baia
VI. Baia
VII. Monte Nuovo
VIII. Lago d'Averno
IX. Monte Grillo, Monte Rosso
X. Cuma
XI. Campiglione
XII. Montagna Spaccata
XIII. 3 Cratere di Campana
XIV. Solfatara
XV. Astroni
XVI. Archiagnano
XVII. Cigliano
XVIII. Quarto
XIX. Pianura
XX. Soccavo
XXI. Naples
XXII. Chiaja
XXIII. Fuorigrotta
XXIV. San Strato
XXV. Santa Teresa
XXVI. Nisida
a. Monte Salvatichi
b. Monte di Procida
c. Monte Ruscello
d. Monte San Severino
e. Pacifico ridge
f. Astroni-Cigliano ridge
g. Crisci mound

(4) In the Phlegræan Fields there is nothing more common than to find volcanic cones denuded on the side facing the sea. It is, therefore, probable that the last vestiges of a volcanic crater ring will be on the land side.

Examined with especial regard to these points, the hills of Baia, Monte Grillo and Monte Rosso, Cuma, Montagna Spaccata, and many others admit of interpretation as segments of volcanic crater walls. Lastly, there are some hills which may possibly be remnants of volcanic cones; but if they are, they are so worn and denuded that I have not been able to assign any position on satisfactory evidence to the vent from which they have been erupted.

The hills of the Phlegræan Fields which are considered

it is assumed that the crater wall ending in the other is the product of a more ancient eruption. If this assumption prove to be correct, we have a very easily observable indication of the relative ages of the intersecting hills. Confirmatory evidence is often supplied by the physiographical characters of the hill slopes themselves. The slopes of the older crater walls seem to be, as a rule, less steep, and to exhibit the weather-worn scars of erosion and denudation to greater perfection than the steeper gradients of the younger crater slopes.

In the table given on p. 584 are set forth the volcanic structures so as to indicate their chronological relationships, so far as I have been able to make them out. The only crater of known age is Monte Nuovo: the most

salient features of its eruption were recorded by an eye-witness in the sixteenth century. The others probably date from prehistoric times; otherwise, such a marvel as an extensive eruption could not have escaped mention by some Greek or Roman author. In the table, the younger volcanic structures are arranged above those which are considered to be older, and lines connect those between which it is thought that some evidence of relative age can be detected.

In my recent paper I have shown that almost all the hills of the Phlegræan Fields are either the entire walls of volcanic craters or of portions of walls of volcanic craters which have been to a greater or less extent washed away by the action of rain or the sea, or have been partially destroyed or buried by more recent volcanic eruptions. Secondly, these volcanic craters are distributed over a crescentic area round the Bay of Pozzuoli; the more recent ones are situated closer to the shore of the bay than the older ones, indicating a gradual march of volcanic vents along lines radiating towards the centre of that bay. In other words, the general effect of volcanic activity has been the accumulation of new land around the bay of Pozzuoli. Inasmuch as water seems to be a necessity for a volcanic eruption, this progression of the volcanoes seawards may stand in some relation to the channels by which water has obtained access to the fires below.

Thirdly, wherever crater rings of a larger and smaller diameter overlap, we never find a larger ring superimposed on a smaller one. The smaller ring is always superimposed on the larger. The conclusion to be drawn is, that the volcanic activity of the region has been decreasing in intensity. The same proposition is proved for a single locality by the Campana series of craters.

As it is impossible to make all the above-mentioned points clear without a suitable map, I would draw the attention of the interested reader to the surveys of the region published by the Istituto Geografico Militare, and to the contoured map published in the *Geographical Journal* for October 1897. R. T. GÜNTHER.

THE PRESENT APPEARANCE OF JUPITER.

IT may be interesting, now that the planet Jupiter is very favourably situated, to call attention to a few of the more conspicuous features which diversify its surface. Many of these objects will be sure to have come under the repeated observation of all those observers who have been habitually examining the planet in their telescopes.

It is fortunate that at the present time there are a large number of conspicuous markings on the planet. These are situated in different latitudes, and will allow some excellent redeterminations to be made of the velocities of the various longitudinal currents.

There are a great many dark and bright spots visible near the equator, on the north side of the southern equatorial belt. Some of these at the date of writing (April 18) are placed in the following longitudes, which are computed on the basis of System I. (daily rate 877°·90 = 9h. 50m. 30s.) in Mr. Crommelin's ephemerides in *Monthly Notices* for January 1898.

	Bright spots.	Dark spots.
	°	°
Long.	80	71
,,	146	94
,,	209	116
,,	238	127
,,	270	155
,,	349	216
		279
		319
		355

These markings are moving at approximately the same rate as the zero meridian System I., but I find that in several cases there is a disposition of the spots to decrease in longitude; hence I believe that their rotation periods will prove to be slightly less than 9h. 50m. 30s. The bright spots exhibit great variations in their appearance, and some irregularities of motion. A spot which is conspicuously brilliant on one night may, a few evenings later, have declined so much that it can scarcely be discerned.

The great red spot is still visible, and its present longitude is about 24°, so that it follows the zero meridian of System II. in the ephemerides by about forty minutes. The spot has the aspect of a faint dusky ellipse with a light interior, and it is connected on its south side with a grey belt. The recent motion of the spot corresponds with a period of 9h. 55m. 41·5s., and it may be expected to drop further behind its computed place unless an acceleration of motion should set in. Comparing an observation of the spot which I obtained on April 17, 1898, 12h. 5m., with one of the earliest by Mr. Dennett, of Southampton, on July 27, 1878, I find that 17,414 rotations were performed in the interim of 7203 days, and that the mean period of rotation was

9h. 55m. 39·4s.

This value is identical with that found by Prof. Hough from 14,505 rotations between 1879–96.

In July 1898 the spot will have been visible during twenty years, and under careful observation at each opposition of the planet. Whether this object is identical with other elliptical or reddish spots seen at various times in the same latitude by Dawes (1857), Huggins (1858–59), Gledhill (1869–70), Lord Rosse (1873), Copeland (1873), Russell (1876), and others, must remain an open question. It appears highly probable that the spot was the same as that observed by Russell in the summer of 1876, but there is an absence of connecting observations in 1877. And the identity of two or more markings cannot be absolutely proved by their longitudes when a fairly long interval has intervened between the observations, because the proper motions of the object are variable, and introduce great differences of longitude not always in the same direction. The retarded westerly drift of the red spot has caused it to lose more than 900 degrees of longitude relatively to its place in 1878, so that the spot has really been displaced to the extent of about two and a half circumferences of the planet.

From my own observations of the spot since 1880, I have obtained the following rotation periods for a certain interval during each apparition:—

Limiting observations.	Rotations.	Period. h. m. s.
1880 Sept. 27–1881 March 17	413	9 55 35·6
1881 July 8–1882 March 30	640	9 55 38·2
1882 July 29–1883 May 4	674	9 55 39·1
1883 Aug. 23–1884 June 12	710	9 55 39·1
1884 Sept. 21–1885 July 8	700	9 55 39·2
1885 Oct. 24–1886 July 24	659	9 55 41·1
1886 Nov. 23–1887 Aug. 2	609	9 55 40·5
1888 Feb. 12–1888 Aug. 22	462	9 55 40·2
1889 May 28–1889 Nov. 26	439	9 55 40·0
1890 May 22–1890 Nov. 25	451	9 55 40·2
1891 Aug. 7–1892 Feb. 2	432	9 55 42·2
1892 Aug. 15–1893 March 8	495	9 55 42·3
1893 Aug. 9–1894 March 24	548	9 55 41·2
1894 Nov. 25–1895 May 10	401	9 55 41·2
1895 Aug. 24–1896 Feb. 22	439	9 55 41·3
1896 Sept. 27–1897 April 25	514	9 55 40·8

The red spot has been falling behind the zero meridian during the last six or seven years, but at a very slow rate, the mean annual retardation being only about six minutes.

There are a number of dark, elongated spots or short belts placed in various regions of the planet. They are

conspicuous objects on nights when the seeing is good, and the times of their passages across the planet's central meridian are easily secured. The following are the longitudes of a few of these formations as computed from System II. of the ephemerides:—

			Long.
		°	°
1.	Dark elongated spot in	Lat. + 15 ...	120
2.	,, ,,	Lat. − 35 ...	150
3.	,, ,,	Lat. + 15 ...	254
4.	,, ,,	Lat. + 33 ...	268
5.	,, ,,	Lat. + 39 ...	282
6.	,, ,,	Lat. + 15 ...	298

Nos. 1, 3 and 6 are placed in the bright tropical zone, and immediately outlying the northern edge of the north equatorial belt. They are moving somewhat faster than the red spot, as their longitude appears to be decreasing at the rate of about 10° per month. Nos. 4 and 5 in the north temperate zone are moving at approximately the same velocity as the red spot.

There are some well-defined irregularities in the north side of the northern equatorial belt, which exhibits both white and dark spots. Their motion is evidently controlled by a rapid current similarly to that of the white and dark equatorial spots, but not, perhaps, quite so extreme.

Bright spots appear in the zone south of the red spot, and several of these are being attentively followed with the object of determining their periods.

On the whole the planet's appearance is now singularly replete with detail, and will compare favourably with that exhibited at any previous opposition. The great red spot has, it is true, long since lost the intense brick-red colour it displayed in the years 1878–81; nor have we now the exceedingly brilliant white equatorial spots of the period named. But appearances are now visible on the disc which were absent then, and among the most interesting of these are the elongated dark spots situated just outside the margin of the north equatorial belt.

Though past observation has fully demonstrated the proper motions of the different markings and the decreasing velocity of several of them, it is highly important that the rate of the various currents should be redetermined every year. The character and number of the spots found in them should also be recorded, and measures made to determine the latitudes of the belts. Pursued through a long series of years, such data might ultimately give us the proof of periodical variations in the character and number of the spots, and possibly also in their rates of motion. W. F. Denning.

THE LONDON UNIVERSITY BILL.

THE friends of education and many friends of the Government are disappointed at the postponement of the second reading of this Bill in the House of Commons. The cynics are saying that aristocratic Government and University representation are either jointly or severally responsible for this recurrent paralysis in the treatment of a question of the greatest importance to the greatest city of the world.

Nature is not a political organ, and these points need not therefore occupy us; we can only express regret that the way in which all matters connected with science and education are handled in this country is so vastly different from that meted out to them in France or Germany. The *Times* writes as follows:

It is no longer denied in any quarter that the absence of a teaching University in the capital of the British Empire and the greatest city in the world is an anomaly and almost a scandal. The alternative which commends itself to Mr. Moulton and the anti-reform party is that a new teaching University should be set up alongside of the present examining University, but this scheme has been rejected by the vast majority of intelligent men who have taken even the slightest pains to look into the subject. What the Government desire—in accordance, we believe, with the immense preponderance of authority on this question—is to connect a teaching University, under which degrees will be given as the hall-mark of a systematic intellectual training, with the existing system of examination pure and simple. The latter, it is pointed out, is left entirely untouched, though there is a strong and growing conviction that it never can be, even in part, a true development of the highest education, but must tend, more and more, to pass under the dominion of the crammer. But the preservation of the existing method of giving degrees makes it imperative, if the teaching work of the University is to be a reality and not a sham, that there should be a double system of examinations, the one for "internal" and the other for "external" students. The Bill provides, necessarily and inevitably, for this distinction, but the most careful securities are adopted that no unfair advantage shall be given to the former class, and, especially, that the examination of students by the teachers who have trained them shall be supplemented and checked by the admission of an independent element. It would seem to be forgotten that the medical degrees of the London University, which undoubtedly stand highest in public estimation and of which the standard is rigorously high, are granted on the reports of examiners many of whom are teachers in the medical schools. The cry for identity of examinational tests is irrelevant and inconsistent. It is, as Dr. Allchin urges, "an attempt to subordinate the examinations to the requirements of those who have neither been trained nor educated in the fullest sense of the word." This is the very essence of the bondage from which for many years past the higher education in London has been struggling, under the guidance of such men as Huxley, to escape, and from which deliverance is now in sight, if Ministers will only have the courage of their opinions and be true to their pledges.

Whether the paralysis comes from want of knowledge or want of courage, it is very clear that there is at the present a great gap in our administrative machinery, and one which a Scientific and Educational Committee of the Privy Council might easily fill if the right men were appointed to it.

NOTES.

The death is announced of Prof. Aimé Girard, member of the Section of Rural Economy of the Paris Academy of Sciences. Referring to the deceased investigator at the meeting of the Academy on April 12, M. Th. Schlœsing remarked: M. Aimé Girard was the highest authority on chemical and agricultural industries in the Academy. After some valuable scientific work he was nominated professor of industrial chemistry at the Conservatoire des Arts et Métiers, in succession to Payen. His teaching revealed the dominating object of his efforts. Affable and cheerful, loyal and entirely disinterested, he possessed all the attributes required to gain the confidence of manufacturers. The producers whose places he visited, in France and in other countries, became and remained his friends; they gave to him a large amount of information which he used to enrich his attractive lectures, and in return M. Girard offered them advice suggested by his experience and his own investigations. In a few years his masterly researches on vegetable fibres, wheat, farinas, sugars and woods had made him the first authority upon these matters, and he was frequently consulted by the Government on subjects concerning the great industries of paper, alcohol, sugar, flour, and bakery. The study of these products led to inquiries as to crops. In this new direction M. Girard rendered valuable services, and, after his researches on the cultivation of sugar-beet and the improvement of the potato, he obtained among agriculturists the same position and the same sympathies which he enjoyed in the industrial world. Though weakened in recent years by illness, and saddened by repeated troubles, he nevertheless continued his work. He died while occupied in applying to wheat of various

origins the new methods of analysis which were the subject of a recent communication to the Academy. The vacancy which his death has caused enables us to estimate the high place which he occupied in scientific societies and in the committees in which he took part.

WE learn from the *Electrician* that a banquet to M. Z. Gramme, to celebrate his receiving the decoration of Commander of the Ordre Léopold, was lately held at the Hôtel Métropole, Brussels. The Senator, M. Montefiore-Lévi, presided, and among the guests, who numbered 130, were Prince Roland Bonaparte, the Minister M. Nyssens, representing the Belgian Government, the Burgomaster and Aldermen of Brussels, M. Mascart (president of the Organisation Committee), M. A. d'Arsonval (president of the Société Internationale des Electriciens), and M. Hippolyte Fontaine, manager of the Gramme Company. M. Mascart, in an eloquent speech, traced the career of M. Gramme, from his commencement as a simple workman in the tiny Belgian village of Jehay-Bodégnée down to the present day, and presented the great Belgian electrician, in the name of the electricians of the whole world, with a fine gold medal engraved by Chaplain. After the banquet the guests were received by the Town Council in the Hôtel de Ville. Profs. Ayrton and Silvanus Thompson, who had been appointed delegates by the Institution of Electrical Engineers, were unable to reach Brussels on account of a storm, and the illuminated address of congratulation, of which they were to have been the bearers, had to be sent by post. Numerous congratulatory telegrams were received, including one from Lord Kelvin and one from Mr. W. H. Preece.

THE ninth international Congress of hygiene and demography was opened at Madrid on April 10. About two thousand members attended the Congress, but less than fifty English delegates were present. The opening ceremony took place in the National Library, under the presidency of the Minister of the Interior, who was supported on the right by the Governor of Madrid, the acting President of the Congress, Dr. Julian Calleja, and by the Secretary-General of the Congress, Dr. Amalio Gimeno; on the left by Prof. Brouardel (Dean of the Paris Faculty of Medicine) and the Mayor of Madrid. Dr. Calleja delivered the inaugural address, and in a few words of greeting extended a warm welcome to the members of the Congress, wisely reminding the audience that the science of public health was confined to no nation in particular and to no one science specially. Dr. Brouardel spoke on behalf of the Permanent International Committee, and he was followed by delegates from the nations represented at the Congress, after which the Minister of the Interior pronounced the Congress open. In the evening a gala performance was given in honour of the members of the Congress at the Spanish Theatre. A reception was held at the Athenæum Literary Club on the evening of Monday, April 11, and on Friday, April 15, there was a reception of the members of the Congress at the house of the Prime Minister, while on Saturday certain delegates had the honour of presentation at Court. The scientific work of the Congress was carried on in the various sections during the whole of last week, and a large number of papers of importance to the science of public health were read.

THE fifth centenary of Paulo Toscanelli and Amerigo Vespucci is being held with much gaiety at Florence. The festivities will continue until the end of this month, and the programme comprises a geographical congress and the inauguration of several monuments.

ABOUT 10·15 p.m. on Tuesday, April 5, a meteor of exceptional size and brilliancy was observed at Ealing slowly traversing the sky in an easterly direction. After a few seconds the meteor burst, and then shot forward with increasing velocity, and disappeared after being visible about ten seconds.

A LECTURE upon "The Progress of Optics during the Present Century" will be delivered at the Mansion House this evening, by Dr. G. Lindsay Johnson, under the auspices of the Worshipful Company of Spectacle Makers. The Lord Mayor, and subsequently the Astronomer Royal, will preside at the lecture.

THE ninth annual meeting of the Museums Association will be held at Sheffield in the first week of July. The Lord Mayor and Corporation of Sheffield offer a cordial welcome to all members of the Association, and are very desirous of making the meeting in every respect successful. All the business will be carried on in the Town Hall, the use of which has been granted to the Association. The President-elect is Alderman W. H. Brittain, and the Secretary is Mr. E. Howarth, Public Museum, Sheffield, to which address communications from members who propose to read papers should be sent.

AT the annual meeting of the Iron and Steel Institute, to be held on Thursday and Friday, May 5 and 6, under the presidency of Mr. Edward P. Martin, the Bessemer gold medal for 1898 will be presented to Mr. Richard Price-Williams in recognition of the active part he took in the early days of the use of steel on railways. Among the subjects of papers that are expected to be read and discussed are: The iron industry of the Urals, by Prof. H. Bauerman; the solution theory of iron, by the Baron Hanns Jüptner von Jonstorff; brittleness in soft steel, by Mr. C. H. Ridsdale; allotropic iron and carbon, by Mr. E. H. Saniter; the crystalline structure of iron, by Mr. J. E. Stead.

THE third annual Congress of the South-eastern Union of Scientific Societies will be held in the Town Hall, Croydon, on June 2-4. On Thursday evening, June 2, the President-elect, Prof. G. S. Boulger, will deliver the annual address. Among the papers to be read on the following day are—entomology as a scientific pursuit, by Mr. J. W. Tutt; the place of geology in education, by Prof. Logan Lobley; the nature of the soil in connection with the distributions of plants and animals, by Dr. H. Franklin Parsons; natural gas in Sussex, by Mr. C. Dawson. On Saturday, June 4, a discussion will take place on ideals for natural history societies, and how to attain them; and Mr. E. M. Holmes will read a paper on botanical work still wanting workers. A museum arranged by the local committee, illustrating the natural history of the neighbourhood and other subjects, will be open during the Congress.

THE *Times* correspondent at Athens writes, under date April 18:—The French School of Archæology was to-day the scene of a brilliant assembly. The King, who was accompanied by the Crown Prince and Princes George and Nicholas, arrived at eleven o'clock, and tendered his congratulations to M. Homolle, director of the School, on the occasion of its jubilee. M. Zaimis (the Prime Minister), M. Romas (President of the Chamber), M. Delyanni, M. Ralli, and all the principal members of Athenian society were present, together with a great concourse of foreign visitors. In the course of an interesting address, M. Homolle made the announcement that M. Syngros, the Greek millionaire, had decided to erect a museum at Delphi. Speeches were then delivered by M. Cavadias, in the name of the Greek Archæological Society, by Dr. Dörpfeld, on behalf of the foreign schools in Athens, and by M. Collignon, as representing various French scientific institutions. Count d'Ormesson, the French Minister in Athens, also delivered an address.

BY establishing a National Zoological Park, having for its chief object the collection and preservation of American animals likely to become extinct, the Smithsonian Institution has been

the means of developing an intelligent interest in such collections in the United States, and has stimulated other enterprises of a similar character. Among similar zoological preserves, which have been projected and established in the United States since the establishment of the National Zoological Park, are the following:—The Blue Mountain Forest Park, established by the late Mr. Austin Corbin, is a large tract of forest and abandoned farm land, situated in the western part of New Hampshire, comprising an enclosed area of 26,000 acres. Within this enclosure are kept about 4000 wild animals, including 74 bison, 200 moose, 1500 elk, 1700 deer of different species, and 150 wild boars. These animals are rapidly multiplying, and, with the exception of the bison, which are sheltered and fed during the winter, live in perfect freedom. In the Adirondack region of New York a game preserve of 9000 acres has been stocked with elk, Virginia deer, mule deer, rabbits, pheasants, &c., and Mr. W. C. Whitney has established a preserve of 1000 acres in the Berkshire hills, near Lenox, Mass., where he maintains not only the species of animals above mentioned, but also bison and antelope. Other preserves are Ne-ha-sa-ne Park, in the Adirondacks, 8000 acres; Tranquillity Park, near Allamuchy, N.J., 4000 acres; the Alling preserve, near Tacoma, Wash., 5000 acres; North Lodge, near St. Paul, Minn., 400 acres, and Furlough Lodge, in the Catskills, New York, 600 acres. These are all fenced enclosures, well stocked with animals. At Pittsburg, Pennsylvania, in one of the public parks, a number of buildings intended for the exhibition of animals are being constructed. These are already nearing completion, and will cost more than 200,000 dollars, exclusive of the animals they are to contain. A further collection of buildings and enclosures intended for American animals only is also projected for that city. Finally, the New York Zoological Society has obtained from the city of New York a grant of some 261 acres in the southern portion of Bronx Park, near that city, for the purpose of establishing there a zoological garden, which is to be free to the public for at least five days in each week. Plans are now being prepared for the development of a collection on the most generous and attractive scale. The bulletin issued by the Society states that it is expected that there will be at once spent 125,000 dollars for preparing the ground, and 250,000 dollars for buildings and enclosures.

THE colony of beavers in the National Zoological Park, Washington, have now made themselves completely at home. The animals have constructed three large dams, one of which is at least 4 feet high. Each of these has been built wholly by the beavers themselves, either from trees felled by them within the enclosure or from branches furnished them for food. They cut this material into suitable lengths, which they drag to the water, float to the dam, and there combine with mud and twigs to form a compact structure. In connection with each dam they have built houses, together with several smaller burrows in the bank. The entrance to the houses is always under water, and can only be reached by diving. The animals have become quite accustomed to the presence of man, and it is believed that under proper restrictions the public may be allowed to see them at work.

DR. A. SLABY, professor of electro-mechanics and heat-mechanics in the Technical High School at Charlottenburg, contributes to the *Century Magazine* (April) an illustrated article upon telegraphy by electric waves—*stromtelegraphie* or "telegraphy by circuit" he terms it. Prof. Slaby describes how he succeeded in establishing communication between Schöneberg, near Berlin, and Rangsdorf, at a distance of twenty-one kilometres. The Emperor of Germany ordered the balloon department of the army to assist in the experiments, and balloons were anchored at the two places chosen for the transmitting and receiving stations. At both stations thin copper wire was fastened to the baskets of the balloons, reaching two hundred and fifty metres to the apparatus. Connection with the earth was made by means of swords stuck in the ground. The first telegram received under these conditions is reproduced in the article, and the clearness of the Morse characters upon it is most remarkable. The distinctness of the dots and dashes seems all the more noteworthy because of the highly electrical condition of the atmosphere on the day of the experiments. The results demonstrated the possibility of using captive balloons on the high sea for purposes of communication by ethereal telegraphy. In place of balloons, kites of the modern form can be used; for Prof. Slaby says a few experiments have convinced him that they are perfectly adapted to carrying the thin wires required to connect with the apparatus. In connection with Prof. Slaby's observations, it is noteworthy that, during the past few months successful experiments on electrical communication without intervening wires have been made at places on the South Coast, under the direction of Signor Marconi. Regular communication has been maintained between Bournemouth and Alum Bay—the distance between the two stations being about 14½ miles. Signals have also been exchanged between stations 18 miles apart, and arrangements are being made to test the capabilities of the instruments to receive at Cherbourg signals transmitted at Bournemouth—the intervening distance being about 60 miles.

THE concluding part of the 26th *Ergänzungsband* of *Petermann's Mittheilungen* contains a very comprehensive account of the distribution of rainfall over the solid portions of the globe, by Dr. A. Supan. The first rain-chart of the world was published by Prof. E. Loomis in 1882, in the *American Journal of Science*. During the last fifteen years the number of rainfall stations has greatly increased, and the quality of the observations has, generally speaking, much improved. Still the distribution is far from satisfactory, as more than half of the observations emanate from Europe, and even there large tracts are badly represented. The construction of a rain-chart always presents great difficulties, because the distribution of rainfall depends so greatly upon local conditions, upon the exposure of the gauges, and the accurate measurement of snow. And to be strictly comparable the periods ought to be the same. But in a comprehensive work, such as that now in question, the author has no choice but to select the best available materials, and this Dr. Supan has done, and gives full particulars as to the sources from which the information is obtained. In addition to tables giving the monthly and yearly values, the author gives a full discussion of the rainfall of various districts, and the charts show very clearly both the mean annual amounts and the seasonal distribution. The work forms a valuable contribution to our knowledge of the subject.

REFERRING to the report from Vienna that Dr. Schiff has successfully treated cases of lupus vulgaris by means of Röntgen rays, the *British Medical Journal* remarks that his process is to set up an independent inflammation in the lupoid area by exposing the part to a very intense radiation. So far, investigations into the germicidal effects of Röntgen rays have gone to show that their activity in this respect is not greater than that of ordinary light. But Dr. Schiff's result is not a germicidal one, and it is known that inflammation, and even necrosis, may result from exposure in certain cases, although the determining factor which leads to injury in some cases but not in others under apparently similar conditions is unknown. It is not, however, altogether improbable that Dr. Schiff's results may be due to a direct germicidal action of Röntgen rays on the tubercle bacillus. Light is deleterious to this organism, and Dr. Finsen, of Copenhagen, has reported cases of cure in lupus by protracted exposure to concentrated light, so arranged that the ultra-violet rays predominated.

We have received the first part (for 1896–97) of the *Transactions* of the British Mycological Society. Descriptions are given of several new Fungi, or of species new to Britain.

The *Botanisches Centralblatt* states that Dr. C. Marchesetti has undertaken a botanical expedition to Upper Egypt and Palestine; and Dr. M. Pedersen (of Copenhagen), an investigation of the vegetation of Disco Island, Greenland.

At the venerable age of ninety, Prof. R. A. Philippi resigns the directorship of the National Museum at Santiago, Chile, which he has held for forty-three years. He is succeeded by his son.

As "Circular No. 13," the United States Department of Agriculture (Division of Botany) publishes a description, with excellent drawings, of the edible and poisonous Fungi natives of the States, by Mr. Frederick V. Colville.

Prof. D. P. Penhallow reprints from the *Transactions* of the Royal Society of Canada a useful review of Canadian botany from 1800 to 1895, being a paper read before the Botanical Section at the last meeting of the British Association.

The *American Naturalist* for February gives a full account of the first annual meeting of the Society for Plant Morphology and Physiology, held at Ithaca, N.Y., on December 28 and 29, 1897, at which many important and interesting botanical papers were read.

The *Botanical Gazette* for March gives a list of the persons officially designated by the Government as botanists or mycologists in the United States, fifty in number. These are situated at fifty-one State experiment stations. Every State in the Union, with the exception of ten, has its State botanist, New York and Connecticut having two each.

The firm of J. B. Baillière et fils, of Paris, is publishing a "Bibliographie Botanique," to appear in five monthly parts of 32 pp., each of two columns. The first fascicle, comprising the letters A to C, will appear shortly. The titles of about 10,000 volumes and pamphlets will be included in the work; the date of publication, number of pages, and some account of the contents will, in each case, be included.

Under the title, *Die Metamorphose der Pflanzen, im Lichte palæontologischer Thatsachen*, the well-known palæontologist, Dr. Potonié adduces arguments, derived from the geological history of plants, in favour of the view that all the higher forms of vegetable life have been derived, by metamorphosis, from the forking of an archaic thalloid structure.

The *Biologisches Centralblatt* continues to publish a succession of interesting papers in both branches of Biology. The phenomena of impregnation in the Rhizopods, non-sexual propagation in Phanerogams, the relationship between the arctic and the antarctic plankton, spermatogenesis in *Paludina vivipara*, the relationships between Phanerogams and Cryptogams, are among the subjects discussed in the most recent numbers.

We learn from the *Journal of Botany* that a new British flora is in preparation by the Rev. E. F. Linton, who will take the *London Catalogue* for the basis of his work. A large number of "forms," and not a few distinct species, have been added to our flora since the publication of the last edition of the existing manuals. The publication is also announced of a flora of Cheshire by the late Lord de Tabley, which will be edited by Mr. Spencer Moore. The flora of Kent, by Mr. F. J. Hanbury and the Rev. E. S. Marshall, is nearly ready for the press.

Petermann's Mittheilungen contains a new geological map of Java and Madura, by Dr. R. D. M. Verbeek, which is a considerable advance on that published by Junghuhn in 1855. A short paper discusses the relation of the topography of the islands to their geological structure.

Dr. Max Eckert, of Leipzig, contributes a paper to *Petermann's Mittheilungen* on the Karren and Schratten districts of the German Alps. Various forms of primary and secondary Karren are recognised; the most typical form occurring in pure chalk at levels where weathering is greatest—*i.e.* between 1600 and 2300 metres.

In a paper published in the *Zeitschrift für praktische Geologie*, Prof. Dr. Rudolf Zuber, of the University of Lauberg, discusses modern theories of the formation of petroleum. The author believes that the hypotheses at present in the field are either too purely chemical or too purely geological, and he criticises a number of them from this point of view, without, however, advancing anything definitely new to take their place.

We have received a reprint, from the *American Antiquarian*, of a paper on the geography of the Tsimshian Indians, by Mr. G. A. Dorsey. The Tsimshian Indians form one of the most important stocks of the North-west; they inhabit villages on the Nass and Skeena rivers of British Columbia, and are distinct in language from the neighbouring tribes. Mr. Dorsey's paper chiefly consists of a list of the villages, and notes as to name, position, &c., of each.

The instruments devised for recording the occurrence of an earthquake, or analysing its motion are very numerous, and are described in many scientific journals. Dr. R. Ehlert has, therefore, rendered a great service by collecting and classifying in one memoir (Gerland's *Beiträge zur Geophysik*, vol. iii.) the accounts of all the more important seismographs and seismoscopes that have so far been constructed.

The latest addition (No. 1084) to the Smithsonian Miscellaneous Collections is a "Bibliography (1748–1896) of the Metals of the Platinum Group"—platinum, palladium, iridium, rhodium, osmium, ruthenium—by Prof. J. L. Howe. The publication of this volume was recommended by the Committee of the American Association for the Advancement of Science having charge of indexing chemical literature. All papers upon metals of the platinum group found in scientific literature to the close of 1896 are given in the order of the date of appearance, and are also indexed according to subjects and authors. It is thus easy to determine what papers have been published upon the physical and chemical characteristics and properties of any members of the platinum group of metals. The volume will therefore be of the highest value to many scientific investigators; and by publishing it the Smithsonian Institution has increased the obligations which men of science owe to the Institution for making works of this character available.

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. H. Times; a Silver-backed Fox (*Canis chama*), a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mr. W. Champion; a Grey-breasted Parrakeet (*Myopsittacus monachus*) from Monte Video, presented by Mrs. Evelyn Heathcote; a Gold Pheasant (*Thaumalea picta*, ♂) from China, presented by Mrs. Abbot Robinson; a Long-necked Chelodine (*Chelodina longicollis*) from Australia, presented by Mr. R. Kirkwood; an Isabelline Bear (*Ursus isabellinus*) from India, deposited; a Red-vented Cockatoo (*Cacatua hæmaturopygia*) from the Philippine Islands, two Toco Toucans (*Ramphastos toco*) from Guiana, a Lapwing (*Vanellus cristatus*, two Knots (*Tringa canutus*) from Lincolnshire, purchased; a Gayal (*Bibos frontalis*, ♀), a Mouflon (*Ovis musimon*, ♂), a Hog Deer (*Cervus porcinus*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Comet Perrine.—The following is a continuation of the ephemeris of Comet Perrine for the ensuing week, from Prof. H. Kreutz's computation :—

1898.	R.A. h. m. s.	Dec. ° ′	Br.
April 22	23 48 19	+46 15·0	0·64
23	53 37	46 50·3	
24	23 58 57	47 24·3	
25	0 4 19	47 57·1	
26	9 42	48 28·7	0·58
27	15 6	48 59·0	
28	0 20 32	+49 28·1	

The Aurora Spectrum.—Prof. E. C. Pickering tells us in a *Circular* (No. 28) of the Harvard College Observatory that the attempts made at photographing the spectrum of the aurora have proved successful, Mr. Edward S. King having obtained two plates, one on April 1, 1897, and the other this year on March 15. On the first of these photographs four bright lines were visible after an exposure of 147 minutes, but uncertainty existed as to the wave-lengths of these lines. In the more recent negative two bright lines were obtained after an exposure of 141 minutes. The brightest of these extends from 3892 to 3925, the wave-length of the second being 4285. Assuming that these two lines were photographed in 1897, the wave-lengths of the four lines then obtained would be 3862, 3922, 4288, 4694.

As regards the first two lines, 3862 and 3922, nothing as yet can be said, as visual observations of the aurora have not extended so far. The line 4288 seems probably to be the same as observed in previous auroræ by Lemström, Wijkander and Oettingen, the wave-lengths given by them being 426, 428 and 424 respectively. The last of the four lines at 469 is a well-observed aurora line. having been seen no less than nine times by observers ; its probable origin is the hot carbon band, which extends from 467–474

Prof. Pickering mentions that the spectroscope employed to obtain these photographs was not specially designed for the purpose, but a new instrument is in course of construction with which it is hoped better results will be obtained.

The Movement of Solar Faculæ.—By a minute study of the magnificent series of observations on sun-spots, made by Carrington and Spörer, the difference between the times of rotation of the spots in different latitudes has been determined with great accuracy. Thus a strict relation was found to exist between the angular velocity of any spot and its latitude, the former decreasing as the latter increased. Dunér further showed that exactly a similar law existed in the case of the general surface of the sun, but with this exception, that the velocities of each latitude for latitude did not agree. An interesting inquiry was then to investigate the behaviour of the faculæ, which recent photographic methods have shown are so numerous over the solar disc. Faculæ, as many observers of the sun know, are not such stable phenomena as spots ; nevertheless Wilsing, after a laborious investigation, came to the conclusion that they were imbued with a velocity that was constant for all latitudes, and equal to a movement of 14°·27 in 24 hours. Belopolsky, at a later date, adopted a different method of investigation, and was led to draw the conclusion that faculæ obeyed the same law of the variation of the angular velocity of rotation as the spots. More recently Wolfer, after a method somewhat analogous to that employed by Wilsing, came to the same conclusion as that arrived at by Belopolsky.

In consequence of the high importance that would be attached to a definite result of so interesting a problem, Dr. W. Stratonoff has undertaken a very complete investigation of the whole subject, using as his data the fine photographs that have been obtained in the last few years (*Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg. Classe Physico-Mathématique*, vol. v. No. 11). Out of a total number of 400 plates, for the years 1891–1894, he used 234 for this research, as will be seen from the following list, showing by whom they were taken :—

1891	60	Belopolsky.
1892	57	,,
1893	76	,, and Stratonoff.
1894	41	Stratonoff, Orbinsky and Evdokimoff.
Total	234	

We cannot enter at length into the details of the method M. Stratonoff has employed in this long investigation, but must confine ourselves simply to the results obtained. The measurements of the heliographic latitudes and longitudes of each of the 1062 faculæ employed are given in the communication in one table, while a second is confined to the heliographic latitude of each facula with its angular velocity of rotation. The sum total of the research is that Wilsing's result is not corroborated, for it is found that the faculæ in different latitudes do not move with a constant velocity ; in fact, the variation of the angular velocity of rotation must be represented by a more complicated law than that in use for the spots. For latitudes 0°–8° the angular velocity of the faculæ remains nearly constant ; from 9°–16° it decreases rather rapidly to the extent of nearly 0°·4 ; for some range of latitude the velocity becomes again nearly constant, tending to increase rather than decrease. A rapidly slowing down of about 0°·5 takes place between latitudes 25° to 34°, and after that in higher latitudes a very gradual diminution in velocity is noticed more pronounced than was the case in the equatorial zone. Thus it will be seen that velocities of rotation at the highest and lowest latitudes differ by nearly a degree, the characters of this variation being the same for both hemispheres. Spots, it may be added, have the tendency to diminish the velocity of rotation of faculæ. As regards the movements of faculæ, spots, and the solar surface, the faculæ in all latitudes have the greatest velocity of rotation ; then come the spots which move more slowly, and lastly the solar surface, which has the least movement of all. M. Stratonoff suggests that perhaps these facts owe their origin in their difference of heights above the envelope of the sun. The author concludes his interesting paper with a series of instructive curves which convey very clearly to the eye the results of the investigation.

YEAST AND ALCOHOLIC FERMENTATION.

Though the knowledge of the existence of alcoholic fermentation and the preparation of alcoholic liquids dates back to very remote antiquity, it is only within comparatively recent times that an accurate acquaintance with the actual nature of the process has been obtained. By the older writers many processes have been confused together under the name fermentation, though they have nothing in common but the evolution of gas which takes place as they go on. The true alcoholic fermentation, the formation of gas in the intestines of animals, and the effervescence which takes place when an acid is poured upon chalk, have all thus been grouped together as comparable phenomena. Of these different processes, however, that of alcoholic fermentation has been made most widely a subject of study, and from about the end of the seventeenth century definite views as to what it really consists of have been entertained by scientific men.

The correspondence between the alcoholic fermentation of the wort of beer, the must of wine and other saccharine liquids, and the disengagement of a gas under the influence of leaven in the manufacture of bread, had been noticed at a considerably earlier period. Very strange ideas were entertained as to the nature and action of the leaven. It was by some writers held to be of the same nature as that of the hypothetical philosopher's stone, and just as the latter was supposed to be able to transmute all metals by contact with them, so the leaven was considered to be able, in some occult way, to transform the dough into something resembling itself. One fact of importance comes out amidst all the mass of confusion, though its interpretation leaves much to be desired. This is the discovery that a very small quantity of leaven is capable of transforming an almost indefinite amount of the dough. The dough was, however, thought to be converted into leaven, and the capability established was distorted into a mark of identity with the philosopher's stone.

It was known, too, at an early date that besides an evolution of gas, alcoholic fermentation is always accompanied by the formation of a deposit in the fermenting liquid, which takes the form sometimes of a sediment, sometimes of a scum floating on the surface. By many writers considerable importance was attached to this deposit, and to it was attributed some special occult force capable of determining the changes which could be observed. These changes were held by some investigators to be chemical in nature, but still to be altogether different from ordinary chemical reactions. Valentin, who wrote towards the close of the sixteenth century, suggests that the deposited matter communicates to the liquid a kind of internal inflammation, and

determines thereby a purification of it, separating its limpid from its turbid constituents. Valentin realised that alcohol makes its appearance in the fermenting liquid, but supposed that it was in some way pre-existent in the extract of the germinated barley grains, and became active and capable of distillation only after being liberated from impurities which accompanied it, and which masked its special properties.

Van Helmont, who wrote in 1648, though confusing fermentation with effervescence, like most writers of the time, yet distinguished that a special gas, which he called the "gas of wine," was produced during the former action, and pointed out that it was different from the spirit of the wine.

Attention was drawn to a distinction between effervescence and fermentation by de la Boë in 1659 and by Lemery in 1675. The first of these writers held the sounder view as to this difference, stating that in effervescence the chief reaction is one of combination, while in fermentation it is a question of decomposition. Lemery held, less accurately, that the chief difference between them was one of relative rapidity, fermentation being a slower and more complicated process. This theory of fermentation is stated by himself in the following words:—

"Pour expliquer cet effet, il faut savoir que le moust contient beaucoup de sel essential; ce sel comme volatil faisant effort dans la fermentation pour se détacher des parties huileuses par lesquelles il etait comme lié, il les pénètre, il les divise et il les écarte jusqu'a ce que par ses pointes subtiles et tranchantes, il les ait raréfiées en esprit; cet effort cause l'ébullition qui arrive au vin, et en même temps sa purification; car il en fait séparer et écarter les parties les plus grossières en forme d'écume, dont une portion s'attache et se pétrifie aux côtés du vase, et l'autre se précipite au fond, c'est ce qu'on appelle le tartre et la lie. L'esprit inflammable du vin n'est donc autre chose qu'une huile exaltée par des sels."

Apparently the first ideas on the subject that may be regarded as at all clear, were advanced by Becher in 1682, and they mark an epoch in the development of our knowledge of it. This author ascertained the fundamental fact that only saccharine liquids are capable of undergoing alcoholic fermentation, and he showed that the alcohol does not exist as such in the original must of wine, but is formed during the operation of fermentation. Becher thought its formation to be due to a kind of combustion, as he ascertained that access of air is needed to set up the phenomenon.

About the same time a theory of the nature of fermentation was advanced, which has much in common with the ideas maintained in later times by Liebig. This was due to Willis and to Stahl, both of whom entertained similar opinions on the subject. It was that the ferment which they recognised as the factor that started the operation is a body possessing a peculiar internal movement or vibration, and that it transmits this vibration to the fermenting material. Of course in the condition of chemical science at the time, there was no satisfactory statement possible as to the nature of the changes caused by such vibration, but Stahl suggested that various decompositions and recombinations resulted therefrom.

The next marked advance in our knowledge must be associated with the name of Lavoisier a century or more later. Up to his time no quantitative researches into the subject had been carried out. The bodies capable of fermentation had been ascertained up to a certain point; besides the alcoholic, the acetic fermentation had been discovered, and a general analogy had been established between fermentation and putrefaction. The products of these fermentations had been ascertained to be carbonic dioxide, alcohol, and acetic acid. Very little acquaintance had been made with the ferment, which was shortly to be recognised as a definite vegetable organism.

While Becher first pointed out the necessity for the presence of sugar in the fermenting liquid, Lavoisier studied quantitatively the relations of the sugar to the derivatives of it formed during the fermentation, and came to the conclusion that the operation consists of a separation of the sugar into two parts, one of which becomes oxygenated to form carbonic dioxide, while the other is converted into alcohol. He says that if it were possible to recombine these two substances, alcohol and carbonic dioxide, sugar would again be formed.

It is apparent that though Lavoisier's methods of analysis were imperfect, and his figures inaccurate in consequence, yet his general conclusions were sound. Towards the year 1815 analyses by Gay-Lussac, Thénard, and de Saussure fixed definitely the composition of sugar and alcohol. These more accurate analyses confirmed Lavoisier's position, but revealed a discrepancy which for a long time remained unexplained. Computation of the composition of sugar based upon the CO_2 and alcohol formed during its fermentation pointed to its having the formula $C_6H_{12}O_6$ (taking the modern values of the atomic weights), the decomposition being capable of expression by the equation $C_6H_{12}O_6 = 2C_2H_6O + 2CO_2$. The analysis made by Gay-Lussac and Thénard of cane-sugar itself demanded the formula $C_{12}H_{22}O_{11}$. These authors were unable to account for the discrepancy which remained unexplained till Dubrunfaut in 1832 observed that before cane-sugar could ferment, it became transformed into another form of sugar which is non-crystallisable. Dumas and Boullay in 1828 tried to reconcile the discrepancy by assuming that the fermentation is accompanied by the absorption of water. We have in the work of these three investigators the substance of what we now know to be true, that the fermentation of cane-sugar involves two processes, the hydrolysis of the cane-sugar with the formation of hexoses, and the decomposition of these with the formation of alcohol and carbonic dioxide.

During the progress of these investigations into the chemistry of fermentation a certain study of the fermenting body was being carried on by various observers. As long ago as 1680 the yeast of beer was examined microscopically by Leuwenhœk, who stated that it was composed of little ovoid or spherical globules, but was not able to determine their nature. Subsequent writers considered them to be of animal origin, but very little was definitely ascertained about them till the fourth decade of the present century, when Cagniard de Latour, repeating Leuwenhœk's experiments, saw that yeast is composed of a mass of organised globules capable of reproduction by budding, and appearing to belong to the vegetable kingdom. He concluded that very probably they disengaged the carbonic dioxide and fermented the liquid by some effect of their vegetation. Before de Latour and writers contemporary with him the yeast was generally considered to be of an animal rather than a vegetable nature, this view being promulgated especially by Fabroni, Desmazières, and Astier, the latter of whom held that it could only live at the expense of the sugar which it decomposed. Since the time of Meyen the true systematic position of yeast has been recognised.

The work of Astier and of C. de Latour laid the foundation for the more complete and satisfactory views of Pasteur, whose researches have thrown so much light upon the whole process of fermentation.

One of the most important discoveries that we owe to Pasteur is that alcoholic fermentation is accompanied by the coincident formation of glycerine and succinic acid, and that, therefore, the equation given above by no means represents all that is taking place in a fermenting liquid. Without committing himself to an equation to represent the whole decomposition, Pasteur determined by quantitative methods that about 4 per cent. of the sugar which disappears in the process of fermentation does not give rise to alcohol, but to glycerine and succinic acid. In addition to ordinary ethylic alcohol, also small quantities of higher alcohols, in varying quantities, are always or generally formed.

Pasteur's theory of fermentation is the natural outcome and the completion of the ideas of Astier and of C. de Latour. In his own words it may be stated: "Mon opinion la plus arrêtée sur la nature de la fermentation alcoolique est celle-ci: L'acte chimique de la fermentation est essentiellement un phénomène corrélatif d'un acte vital, commençant et s'arrêtant avec ce denier. Je pense qu'il n'y a jamais fermentation alcoolique sans qu'il y ait simultanément organisation, développement, multiplication de globules, ou vie continuée, pour suivie, des globules déjà formés."

This hypothesis, originally advanced by C. de Latour, did not, however, obtain acceptance at once. It was opposed strongly by Liebig, who put forward a view which is a modification of that advocated so long before by Willis and by Stahl. According to Liebig, the cause of fermentation is an internal molecular movement or vibration which a body in the course of its decomposition communicates to other matters whose elements are held together with very feeble affinity. Liebig says: "La levure de bière, et en général toutes les matières animales et végétales en putréfaction, reportent sur d'autres corps l'état de décomposition dans lequel elles se trouvent elles-mêmes; le mouvement qui, par la perturbation d'équilibre, s'imprime à leurs propres éléments, se communique également aux éléments des corps qui se trouvent en contact avec elles."

This explanation seemed to apply to all fermentations besides the alcoholic one, and was for that reason favourably received by many; some, indeed, thinking that all fermentations were fundamentally alike, and that the different products were due to the degree of the alteration of the decomposing substance.

This view led to the idea that the action of the yeast was not due to its vital processes, but rather to a decomposition of its proteid constituents regarded simply as nitrogenous substance.

A third hypothesis was advanced by Berzelius, who thought that fermentation is a contact action due to a catalytic force. This idea has met with very little support.

Pasteur's biological explanation of the action of yeast gradually made itself accepted, even to a certain extent modifying Liebig's position. The latter chemist, in his later writings, while adhering to his theory of a molecular vibration, insists that it is not antagonistic to Pasteur's views, but that the movement is set up by the organisms in the course of their vital activity.

The dependence of alcoholic fermentation on the presence of yeast in a living and active condition seemed, so far as the earlier observers went, to be absolute, and the power of the organism to bring it about appeared to indicate a special property of the yeast cell. The question, however, was soon raised whether or no this property was shared by other organisms than this simple one; whether, in fact, it was not rather a manifestation of certain powers of vegetable protoplasm when placed under abnormal conditions. Reasons for holding the latter view were soon forthcoming.

In 1869 MM. Lechartier and Bellamy published an account of some experiments made with ripe fruits, which they kept for several months in the absence of oxygen. They found that under these conditions the fruits gave off continuously a certain quantity of CO_2, and that at the end of the experiment the pulp contained a measurable quantity of alcohol. Microscopic examination of the pulp showed it to be free from any yeast cells. These observations were shortly afterwards confirmed by Pasteur.

In speculating as to the part which these fermentative processes play in the life of the vegetable cell, Pasteur came to the conclusion that the fermentative power was connected with nutrition in the absence of free oxygen, and that the effort to obtain oxygen under these conditions led to the decomposition of the sugar. He strengthened himself in this opinion by experiments on the cultivation of yeast in the absence of free oxygen, carried on side by side with others in which the gas was supplied freely to the organism. In these experiments he found that the relative weights of yeast formed and sugar decomposed were very different under the two conditions. When no oxygen was supplied, fermentation was very slow, and for one part of yeast formed 60 to 80 parts of sugar disappeared. When oxygen was admitted the fermentation was very rapid, but for one part of yeast formed not more than 4 to 10 parts of sugar were decomposed. This difference was not due to any weakening of the energy of the yeast in the second case, for when some of it was removed and made to act on sugar in the absence of oxygen, it behaved just as did that which was used in the first experiment.

In this way Pasteur was led to hold that fermentation is a kind of intra-molecular respiration, a view which, however, was not allowed to pass without challenge.

Schützenberger argues against it with some force, pointing out at the outset that there seems to be a contradiction between the facts and Pasteur's inferences. In the presence of free oxygen we have a very active fermentation set up, while the yeast is said to possess less fermentative power. Schützenberger claims that the fermentative power is not the same thing as the power of growth, nutrition, and multiplication; that it is a distinct quality which exists in the yeast cells so long as they are living, but is not directly related to the respiratory process.

He bases his view on experiments carried out to ascertain how respiration is affected under changed conditions. The results he obtained were briefly the following:—

(1) In a watery liquid without sugar, but containing oxygen in solution, the quantity of oxygen absorbed in unit time by a gramme of yeast is constant, whatever proportion of oxygen is present.

(2) In a saccharine liquid, containing also albuminous matter, and with oxygen in solution, the same result is obtained, except that the quantity absorbed in unit time is greater.

(3) In two digestions, carried on side by side for some time, one being supplied continuously with oxygen and the other deprived of it, the former produced most alcohol.

If the decomposition of the sugar had been the result of the respiratory activity of the yeast cells at the expense of the combined oxygen of the sugar, it would seem that fermentation should either not have taken place at all in the presence of free oxygen, or that it should have been much less than in the other case, whereas the reverse is what is found.

Hence, Schützenberger comes to the conclusion that the sugar is alimentary and not respiratory.

Pasteur's theory has also found a powerful opponent in Naegeli, who held views much like those advanced by Liebig, Willis and Stahl. He thought that the decomposition of the sugar is brought about by vibrations of the plasma molecules, transferred to the fermentable substance, and that it takes place to a small extent only inside the cells, but to a much greater one in the liquid outside them.

A great development of our knowledge of the details of fermentation has taken place during the last twenty years, due in large measure to the labours of Hansen. Prior to 1878 much uncertainty prevailed concerning the true Saccharomycetes. By most laborious and careful cultivation, an acquaintance has been made by him with the life-history and mode of behaviour under various conditions of six definite species of these fungi. Other investigators have described other species, and a copious literature has sprung up on the subject.

Another fact of importance has also been ascertained which explains the discrepancies of analysis observed so long ago by Gay-Lussac, Dumas and others. It was mentioned above, that the composition of the fermented sugar as computed from the measurement of the CO_2 and alcohol it furnished, must be expressed by the formula $C_6H_{12}O_6$, while the analysis of cane-sugar showed it to be $C_{12}H_{22}O_{11}$. Dumas suggested that it took up water during the alcoholic fermentation. It is now known that this hydrolysis takes place before such a fermentation begins, and that it is set up by a special enzyme which can be extracted from yeast. If a watery extract be made of yeast pressed till nearly or quite dry, the cells give up to the solvent a body which has been called *invertin* or *invertase*. When a liquid containing this is added to a solution of cane-sugar, the latter is found to be very rapidly split up according to the equation

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6.$$

Two sugars are formed, one of which rotates a beam of polarised light to the right, the other to the left. These, which were on this account termed *dextrose* and *levulose* respectively, are now known as *glucose* and *fructose*. These two sugars are those which undergo the alcoholic fermentation, while the cane-sugar itself is incapable of so behaving. The extract of the yeast can carry out the hydrolysis without the cells themselves being present.

More recently still, the sugar *maltose*, which is the product formed by the action of diastase on starch, and which is consequently always present in malted grain, has been ascertained to undergo a similar hydrolysis to cane-sugar, but to yield two molecules of glucose in consequence. The enzyme which causes this hydrolysis is also present in the malt. It is called by some writers *glucase*, by others *maltase*.

Fischer states that such an hydrolysis is necessary in the case of all polysaccharides, or sugars with the empirical formula $C_{12}H_{22}O_{11}$. Thus the sugars which are immediately capable of giving rise to alcohol are especially glucose and fructose; those which are commonly found in the liquids which are fermentable being, in addition, cane-sugar and maltose. The latter always undergo conversion or hydrolysis, and form one or both of the former.

The course of action on mixtures of these sugars in the presence of different species of yeast is often very different. Thus Hansen's six true species of Saccharomycetes all hydrolyse both cane-sugar and maltose, besides carrying on alcoholic fermentation of their products. *S. Marxianus* differs in not attacking maltose, while *S. membranæfaciens* ferments none of them, and does not contain invertase. Other organisms have similar idiosyncrasies.

Fischer advances a hypothesis to explain this great variety of action, which throws a great deal of light on the subject. Recognising, as it is now possible to do, that different sugars have different molecular configurations, he suggests that the ferment-

ative principle of the yeast, whatever it may be, must possess a corresponding or complementary configuration, and so be able to come into very close relation to the molecule of the sugar it ferments, much as a key can only unfasten a lock for which it is constructed and to whose parts its own shape corresponds. The configuration of the two fitting as it were into each other, the disruption of the sugar molecule by the action or possibly vibration of the fermentative principle becomes conceivable.

Fischer does not base this hypothesis upon supposition merely, but has tested it by studying the action of some of the soluble enzymes upon the bodies they attack. His results with invertase are very interesting. According to Van 't Hoff's stereochemical theory, there are possibly to be found two methylglucosides, α and β, which differ only in their configuration. Fischer synthesised both these bodies and heated a quantity of each with 20 times its volume of invertase solution to 30–33° C. At the end of some time about half of the α body was hydrolysed, yielding glucose as one of its products. The β body underwent no change. Yet the two methyl-glucosides have the same composition, are formed from the same alcohol (methyl alcohol) and from the same sugar (glucose), and differ only in the configuration of a single carbon atom rendered asymmetric by the introduction of the methyl group into the sugar.

The great advances made in the study of fermentations under the action of soluble enyzmes during late years, has drawn the attention of many to the possibility of the secretion of an alcohol-producing enyzme by the yeast cells. It is evident that the introduction of the idea of an enyzme need not involve a new view as to what fermentation itself is. It is only necessary to substitute the secreted enzyme for the protoplasm of the cell, as the active agent in the process.

The idea was advanced some time ago by Berthelot, who compared both lactic and alcoholic fermentations to the conversion of starch into sugar. It has also been suggested by Moritz Traube and by Hoppe-Seyler.

The enyzme has, according to Buchner, actually been prepared from very active yeast by grinding the cells and squeezing the fluid contents from the resulting mass under the very heavy pressure of 500 atmospheres to the square inch.

As a review of Buchner's work appeared in this journal comparatively recently, it is not necessary to recount his experiments in detail.

The discovery, should it be confirmed, deals a very heavy blow to the vibration theories of fermentation due to Liebig and Naegeli. Their views are only tenable on the theory that most, if not all, of the action takes place in the liquid outside the cells. If Buchner is correct, and the work is done by means of an enzyme, it must necessarily be *intra-cellular*, for enzymes, so far as they have at present been investigated, show no tendency to diffuse through such a membrane as the cell wall. It also militates against Pasteur's theory of intramolecular respiration, which demands the idea of the decomposition being brought about by chemical action between the protoplasm and the body from which it, according to the theory, obtains its oxygen.

J. REYNOLDS GREEN.

THE METALS USED BY THE GREAT NATIONS OF ANTIQUITY.[1]

AT the beginning of this century little was known of the great nations of antiquity, except through the classic poets and historians, and the sacred writings of the Hebrew people. Since then our knowledge has been enormously increased by the labours of scholars and explorers; the ruins of ancient cities have been exhumed, and the contemporary literature of Egypt and Assyria, inscribed on papyri or tablets of clay, and painted or carved on the walls of temples, palaces and tombs, has been deciphered. What is in some respects still more important is, that objects found in these ruins have thrown great light upon the daily life of the people, and their ornamental and useful arts. One of the departments of this inquiry concerns the metals used by the different nations, and at the different epochs of their history; and it is to this that my attention will be confined this evening. The difficulty I experience is the vast amount of material; and I cannot attempt anything more than a general view of the subject, and some of the most salient points.

The area over which the inquiry extends is that of the lands bordering on the eastern half of the Mediterranean, and stretching eastwards to the Persian Gulf. The time, so far as Egypt is concerned, includes the whole period from the first Pharaoh, Menes, to the conquest of the country by Alexander the Great; ranging from about B.C. 4400 to B.C. 332. The chronology employed throughout is that of Dr. Wallis Budge, of the British Museum, who has adopted in the main that of Brugsch Bey. This period of 4000 years appears to me reasonable, and errs, if anything, on the side of moderation. Our knowledge of the other nations does not extend to anything like so remote a time.

[1] A Friday evening discourse delivered at the Royal Institution, on February 11, by Dr. J. H. Gladstone, F.R.S.

EGYPT.

If we take as our starting-point Seneferu's triumphal tablet in Wady Maghara, in the Sinaitic peninsula, we see the king flourishing his battle-axe over the head of his enemy. This symbolises the conquest of the copper and turquoise mines of that region, and implies, of course, their previous existence as a source of wealth. In the hieroglyphic inscription above his head there is not only the king's name spelt phonetically, but in the royal titles are seen two ideographs which bear upon our subject. One is the necklace or ornamental collar which is the well-known symbol for gold; and the other an axe, the head of which resembles rather that of a copper than of a stone weapon. These titles have no reference to the metals themselves, but mean "Golden Horus" and "Beneficent Divinity." Before such symbols could be used to express abstract ideas, they must have been well known in their concrete form. The date assigned to Seneferu is B.C. 3750; but the discoveries of the past year have put in our possession the actual metals themselves, of a much greater antiquity. M. de Morgan, late Director General of Antiquities in Egypt, has explored an enormous royal tomb at Nagada, the centre chamber of which contained the mummy of the Pharaoh, with the cartouche of King Menes, the reputed first King of Egypt. If it be really his tomb, the probable date will be B.C. 4400. What is interesting to us is that in two of the chambers, among a multitude of articles made of ivory, quartz, porphyry, wood, alabaster, tortoiseshell, mother-of-pearl, obsidian, earthenware, cornelian, glass and cloth, there were found some small pieces of metal, viz. two or three morsels of gold, and a long bead of that metal of a somewhat crescent form, together with some articles of copper—a kind of button, a bead, and some fine wire. The button was analysed by M. Berthelot, the well-known French chemist and politician, to whom we are indebted for the examination of a very large number of ancient metallic objects; he states that it is nearly pure copper, without arsenic or any other metal in notable proportion.

These are the oldest metallic objects in the world to which we can assign a probable date. But Prof. Flinders Petrie had discovered, three years ago, also at Nagada, a great number of objects of the same character, and among them a few small copper implements. Some filings from a dagger, a celt, and a little harpoon were analysed by me, and found to consist of practically pure copper, without any trace of tin. The remains of these filings are in the little bottles on the table. The age of these tools must be comparable with that of the royal tomb, and may possibly be even older.

Of about the same period, and perhaps even earlier, are a number of tombs at and near Abydos, which have been explored by M. Amélineau, bearing the names of kings unknown to history, accompanied by hieroglyphics of archaic form. In these have been found larger quantities of copper utensils, viz. pots, hatchets, needles, chisels, &c., which M. Berthelot also finds to be nearly pure metal, but some contain a little arsenic. It would appear, therefore, that the Egyptians, at the very beginning of the historic period were acquainted with the use of gold and copper. Let us follow the history of these two metals, beginning with gold, which, as it is generally found native, was probably the first known to man.

According to a letter just received by me from M. Berthelot, all or nearly all the ancient gold that he has examined contains more or less silver. This pale coloured gold is sometimes termed electrum, and was found in great quantity in Asia Minor, where the Pactolus and other streams "rolled down their golden sands." Gold is frequently represented in the Egyptian sculptures and pictures; for instance, in the very interesting scenes of social life at Beni Hassan, *circa* B.C. 2400, illustrations of which I now throw upon the screen, we see the goldsmiths making jewellery, weighing out the metal, melting it in their little furnaces with the aid of blowpipe and pincers, washing it, and working it into the proper forms. In the picture of a bazaar at Thebes we

find a lady bargaining for a necklet; and in another picture we see the weighing of thick rings of gold and of silver, which were used as articles of exchange. I wish I could show you the exquisite gold jewellery, inlaid with gems, found in the tombs of four princesses buried at Dahshur, about B.C. 2350, and which is now exhibited in the museum of Gizeh; but I can throw upon the screen the photograph of the beautiful enamelled gold necklace of Queen Ahhotpu, B.C. 1700. The great kings Seti I. and Rameses II., B.C. 1300, worked extensive gold mines in Nubia, which yielded gold free from silver.[1]

To return to the history of copper. In the inscriptions we cannot distinguish between copper and its various alloys, for they are all expressed by the general term *chemt*, and the symbol of the battle-axe blade. But if we can get the substance itself and analyse it, we know what we are dealing with. Many specimens of copper implements dating from the fourth to the sixth dynasty, say from B.C. 3750 to 3100, have been examined. They consist of almost pure copper. One of the earliest, analysed by me, was a piece of a vessel from El Kab, which contained 98 per cent. of copper, the remaining 2 per cent. being made up of bismuth, arsenic, lead, iron, sulphur, and oxygen, evidently the impurities in the original ore.

It was evidently very important for the Egyptians to harden the copper as much as possible; and this might be effected in several ways: (1) by hammering, (2) by the admixture of arsenic, (3) by the admixture of tin, (4) by the admixture of zinc, (5) by the presence of a certain amount of oxygen in the form of cuprous oxide. As to arsenic, some of the oldest copper implements contain a notable quantity. Dr. Percy found 2·29 per cent. in a knife which was dug up some distance below a statue of Rameses II.; and I found 3·9 per cent. in a hatchet from Kahun, dating back to B.C. 2300. It is said, however, that the addition of 0·5 per cent. of arsenic is sufficient to produce a hardening effect; and many specimens of ancient copper implements contain this amount, though the proportion of arsenic in copper ores themselves rarely exceeds 0·1 per cent.

As to the mixture of tin. It is well known that bronze, the alloy of copper and tin, is stronger than pure copper. The extent of this depends upon the proportion of the two metals, and probably on other circumstances. The oldest supposed occurrence of an admixture of tin is in a bronze rod found by Flinders Petrie in a mastaba at Medum, probably of the fourth dynasty, which I found to contain 9·1 per cent. of tin. It seemed so improbable that tin should be employed at so remote a period, and that in sufficient quantity to make what we call gun-metal, that I was suspicious of its genuineness, notwithstanding the very circumstantial account of its discovery; but M. Berthelot has since found in a ring from a tomb at Dahshur, believed to be not much later than the third dynasty, 8·2 per cent. of tin; and in a vase of the sixth dynasty, 5·68 per cent. of tin. These seem to restore the credit of Dr. Petrie's specimen. At a later period weak bronzes become common. Thus, at Kahun tools found in a carpenter's basket by Prof. Petrie contained varying amounts of tin from 0·5 to 10·0 per cent.; 6 or 7 per cent. of tin was subsequently common. Bronze implements abound in Egypt. I am able not only to throw upon the screen representations of arrow- and spear-heads and battle-axes, but, through the kindness of Sir John Evans, to show a beautiful large spear-head with an inscription of King Kames (B.C. 1750) down the blade. I am also indebted to Prof. Flinders Petrie and Dr. Walker for this collection of implements of the twelfth dynasty from Illahun, including a fine mirror with ivory handle, necklets, and a bronze casting for a knife which was never finished; also many objects of the eighteenth dynasty, or thereabouts, such as a sword, dagger and axe, together with mirrors, bracelets, earrings and pendants, and a steelyard. My own collection contains specimens of what are believed to be razors of different types, and small statuettes.

As to the admixture of zinc. There does not seem to be any specimen of brass, properly so called, found in Egypt within the period of our inquiry; but various attempts are known to have been made to imitate gold, of which aurochalcum is an instance, and that may have been yellow brass.

As to oxygen. It is generally supposed to exist in copper in the form of the red cuprous oxide; and most of the copper, and many of the bronze, implements have a covering of this substance. This is caused by the gradual formation of an oxychloride of copper through the action of alkaline chlorides in the soil, aided by the air and moisture. Berthelot has worked out the chemistry of this substance very fully, and shows how when once formed it gradually works its way into the solid metal, transforming it into the suboxide, and frequently disintegrating it. Some good specimens of little bronze images suffering this disintegration are exhibited by Mr. Joseph Offord. Two at least of the copper adzes on the table consist to the extent of 30 or more per cent. of oxide of copper; they are exceedingly hard, and it becomes a question whether the formation of the oxide is due to the slow chemical change, or whether it was purposely produced in the manufacture in order to harden them. The effect of different proportions of oxygen on the tenacity of copper is known to be very various, and certainly deserves further investigation.

It is difficult, or rather impossible, to express in definite figures the advantage gained by the ancient Egyptian metallurgists through this alloying of the copper. Arsenic, tin, or zinc may and do affect the hardness or the tenacity, or the elasticity, in different ways, and also according to the proportion of the metal united with the copper. Thus there are several very different kinds of alloys of copper and tin, though they are all included under the name of bronze; moreover, a piece of copper which has been exposed to a considerable stress is permanently altered in its properties. Again, in any table of numerical values it should be taken into account whether the copper with which the alloys are compared had been made as pure as possible, or contained a normal amount of oxygen.[1] We must rest contented with the knowledge that copper can be rendered stronger and more serviceable by these means, and that the ancient artificers were acquainted with the fact.

After the extensive use of copper and bronze in ancient Egypt, other metals were gradually employed. Silver, as distinct from electrum, seems to have been little used, except for ornamental purposes.[2] The diadem of one of the kings named Antef (B.C. about 2700), and that of the Princess Noubhotep (B.C. 2400), were made of silver and gold. Silver also occurs among the beautiful jewellery of the princesses buried at Dahshur, and that of Queen Ahhotpu. But when the intercourse between Egypt and the neighbouring nations of Asia was better established, silver became much more common; thus we find it frequently mentioned in the Great Harris papyrus (B.C. 1200), in which the King Rameses III. describes his magnificent presents to the temples and priesthood of Egypt. The metal lead also occurs frequently in the same lists, and was used, as elsewhere, for mixing with copper and tin in the formation of the easily fusible bronze used for statuary.

Tin has a more interesting history. We have found it used in combination with copper as far back as perhaps B.C. 3400, and enormous quantities of it must have been afterwards employed. It is still a question whether in the first instance some stanniferous copper ore was used, or whether the Egyptians found that the addition of a certain black mineral was advantageous for hardening their copper, or whether from early days they reduced the metal from its ore and added it to the copper in the furnace. That, at any rate, they were afterwards acquainted with the metal itself, is clear from the discovery by Flinders Petrie of a small ring at Gurob (B.C. 1450), which, on examination, I found to be of tin, imperfectly reduced from its ore. Berthelot has also analysed what was essentially a tin ring, though alloyed with copper, dating about a century later; and Prof. Church describes a scarab of the same metal, which was found on the breast of a mummy of about the seventh century B.C. This metal also appears more than once among the rich gifts catalogued on the papyrus of Rameses III., if "*tehi*" is to be so translated.

Although kohl, the sulphide of antimony, was used for blackening the eyebrows from a very early period, I am not aware of any metallic antimony in Egypt of older date than some beads found by Prof. Petrie at Illahun in a tomb of about 800 B.C. They proved to be fairly pure metal. It is curious that the art

[1] Since the lecture was delivered the Egypt Exploration Fund has issued a memoir, under the title of "Deshasheh," from which it appears that in the very ancient tombs at that place there were found a few gold beads and copper objects, and a picture of an artificer weighing a copper bowl.

[1] For tabulated results of experiments bearing on these points, see "The Testing of Materials of Construction," by Prof. Cawthorne Unwin; and the second Report to the Alloys Research Committee of the Institution of Mechanical Engineers, by Prof. Roberts-Austen, with the discussion thereon.—*Proc. Inst. Mech. En.*, April 1893.

[2] In the translation of "The Book of the Dead," by Dr. Wallis Budge, vol. iii., published since the lecture, it appears that in one of the oldest chapters, said to have been found by Herutataf, about B.C. 3600, there is a formulary to be said over a scarab of greenstone encircled with a band of refined copper, and having a ring of silver.

of preparing this metal was afterwards lost, and only rediscovered in the fifteenth century of our era.

The period of the first use of iron in Egypt is at present a matter of great controversy. Some contend for its use even in the mythological period, while others would bring it as late as 800 or 600 B.C. There exist the oxidised remains of some wedges of iron intended to keep erect the obelisks of Rameses II. at Tanis, which is near the border of Palestine; but there is no positive proof that they were placed there during his reign. I have little doubt, however, that the Black *Baa*, mentioned several times in the Harris papyrus, B.C. 1200, is the same as the *μελας σιδηρος* of Hesiod; *i.e.* iron. In the long account which King Piankhi gives of his invasion of Egypt from the Upper Nile, he mentions iron more than once among the presents made to him by the minor chieftains of the time in token of their submission, indicating that at this period, B.C. 700, it was still not very common.

Assyria.

In the country lying between or near the Euphrates and the Tigris we have some antiquities dating, perhaps, as far back as any in Egypt. We have also a great amount of Accadian and Assyrian historical and other literature on tablets and cylinders of clay, and on the walls of the great palaces and temples. As in the case of Egypt, the discoveries of the remotest age are those which have been most recently published. Dr. Peters has just given us the records of the explorations of the American Oriental Society at Nippur, and describes the successive layers of the great temple of Bel. These appear to indicate the absence of metal in very remote periods. The oldest specimens are those recently found by M. de Sarzec at Tello (Lagash) in Southern Chaldæa. They consist of some votive statuettes, and a colossal spear, an adze and curved hatchet, all of copper without tin, according to M. Berthelot's analysis. A small vase of antimony, and a large one of silver have also been found. The period of these is supposed to be some considerable time anterior to B.C. 2500. At Tel el Sifr, in the same neighbourhood, Mr. Loftus discovered a large copper factory, in which were cauldrons, vases, hammers, hatchets, links of chain, ingots, and a great weight of copper dross, together with a piece of lead. The date of these is believed to be about B.C. 1500. At Nippur the American explorers found at a higher level, in the temple of Bel, what they term a jeweller's shop, which consisted of a box full of jewellery, mainly precious stones, but also containing some gold and copper nails; these apparently date from about B.C. 1300. In Babylonian graves and other places of about the same period there have been found objects made of copper and iron and silver wire; but the use of metals seems much more restricted in these great alluvial plains than in contemporary Egypt. Iron, however, was perhaps an exception. According to Messrs. Perrot and Chipiez, excavations at Warka seem to prove that the Chaldæans made use of iron sooner than the Egyptians; in any case, it was manufactured and employed in far greater quantities in Mesopotamia than in the Nile Valley; in fact, at Khorsabad M. Place found hooks and grappling irons, fastened by heavy rings to chain cables, picks, mattocks, hammers, ploughshares, &c., in all about 157 tons weight. Mr. Layard also found at Nimroud a large quantity of scale armour of iron in a very decomposed state, but exactly resembling what is represented in the sculptures of warriors. Of this he collected two or three basketfuls.

Coming down to the period of the great Babylonian Empire, we find very large treasures of the precious metals changing hands during their sanguinary wars. Thus, on the black obelisk of Shalmaneser II. in the British Museum, we have depicted the embassies from different nations bringing their tribute to the feet of the king; the second of these has an inscription reading: "The tribute of Jehu, son of Omri; silver, gold, bowls of gold, vessels of gold, goblets of gold, pitchers of gold, lead, sceptres for the king's hand, and staves; I received." The gates of his palace at Balawat, now at the British Museum, were of stout timber strengthened with bands of bronze, and the Trustees kindly gave me a small piece of the metal for analysis; it yielded about 11 per cent. of tin. The grandson of this king, Rimmon Narari III., probably B.C. 797, took Damascus, and the spoil, according to the inscriptions, comprised 2300 talents of silver, 20 of gold, 3000 of copper, 5000 of iron, together with large quantities of ivory, &c.

Lenormant gives two verses of a magical hymn to the god Fire, which exist both in Accadian and Assyrian; they run—"Copper, tin, their mixer thou art; gold, silver, their purifier thou art."

Palestine.

Between the great territories of Egypt and Assyria lies a narrow strip of country, small in extent, but very important in the history of civilisation, commerce and religion. During the period of which we are speaking it was occupied by a succession of different nations. It formed part of the possession of the great Hittite people. We cannot read their inscriptions, and we know little of their history. We have, however, bronze and silver seals that are supposed to belong to them, and curious bronze figures. They seem to have had abundance of silver, probably from the mines of Bulgardagh in Lycaonia. We read of Abraham purchasing a piece of land from Ephron the Hittite for which he weighed out "four hundred shekels of silver current money with the merchant." He was, in fact, rich in silver and gold, and among the presents given to Rebekah were jewels of silver and jewels of gold.

The first notice of metals in Palestine to which we can give an approximate date is in connection with the invasion of that land, and other countries further to the eastward, by the great Egyptian King Thothmes III. He led his army through the plain of Esdraelon, and gained a victory at Megiddo, and amongst the spoil were chariots inlaid with gold, chariots and dishes of silver, copper, lead, and what was apparently iron ore. This took place about B.C. 1600. The original of the long treaty of peace and amity between Katesir, King of the Hittites, and Rameses II. is said to have been engraved on tablets of silver.

When the Children of Israel left Egypt they were, of course, acquainted with the metals used in that country. They borrowed the jewels of silver and gold of their oppressors; and of these the golden calf was afterwards made. We read, too, of the "brazen serpent,"[1] and of elaborate directions for the use of silver, gold, and brass in the construction of the Tabernacle. Lead is mentioned once, but iron seems to have been unknown to them, the word never occurring in the Book of Exodus; and though it is occasionally mentioned in the later Books of Numbers, Deuteronomy and Joshua, it is always with reference, not to the Israelites, but to the nations they encountered. Thus we read of the Midianites having gold, silver, copper, iron, tin and lead, which were to be purified by passing through the fire; of the King of Bashan, a remnant of the Rephaim, who had the rare luxury of an iron bedstead, which was kept afterwards as a curiosity at Rabbah; and of the spoil of the Amorite city of Jericho, comprising gold, silver, copper and iron. Later on the Canaanites were formidable with their "nine hundred chariots of iron"; and later still the Philistines, whose champion, Goliath of Gath, was clad in armour of bronze, and bore a spear with a heavy head of iron. Among the materials collected by David in rich abundance for the building of the Temple were gold, silver, bronze and iron; but the best artificers in metals were furnished by Hiram of Tyre, at the request of Solomon. During the reign of the latter there was an immense accumulation of these precious metals in Jerusalem. The comparative value of the different materials is indicated by the words of the prophet in describing the Zion of the future, "for brass I will bring gold, and for iron I will bring silver, and for wood brass, and for stones iron" (Isaiah lx. 17). Another prophet (Jeremiah vi. 29, 30) uses the simile of the refining of silver by the process of cupellation.

The great mound of Tel el Hesy affords a very perfect example of the débris of town upon town during many centuries; and of the light that these mounds throw upon the progress of civilisation. When Joshua, after the decisive victory of Beth-horon, led his troops to the plain in the south-west corner of Palestine, he besieged and took Lachish, a city of the Amorites. It then became an important stronghold of the Israelites: its vicissitudes are frequently mentioned at various dates of the sacred history, as well as on the Tel el Amarna tablets. The mound has lately been explored by Messrs. Petrie and Bliss; and in the remains of the Amorite city (perhaps B.C. 1500) there are large rough weapons of war, made of copper without admixture of tin; above this, dating perhaps from 1250 to 800, appear bronze tools, with an occasional piece of silver or lead, but the bronze gradually becomes scarcer, its place being taken by iron, till at the top of the mound there is little else than that metal. The Palestine Exploration Fund has kindly lent me specimens of these finds for exhibition. About B.C. 700,

[1] The word "brass" at the time of the translation of our Bible was used indiscriminately for copper or any of its alloys. In the Old Testament it never refers to the alloy of zinc, to which the term is now confined.

Lachish was the headquarters of Sennacherib, during his invasion of Palestine. From it he sent his messengers to Hezekiah, and at the same town he received the peace offering of the Jewish king, 300 talents of silver and 30 talents of gold, to raise which he had to despoil his palace and the Temple. In Sennacherib's own version of the transaction, the silver is given as 800 talents, and the gold 30. Lachish was finally deserted about 400 B.C.

GREECE.

We know little of the very early history of Greece, for the most ancient monuments bear no inscriptions, and literature did not commence till the time of the Homeric poems. In these, and in Hesiod, there are many graphic descriptions of the habits and arts of the heroic period, including the use of metals; and many of the towns described in them have recently been explored with great success, and have yielded up the very materials about which they sang.

Probably the earliest find has been in the volcanic island of Santorin, where, under beds of pozzolana, which are supposed to date about 2000 B.C., have been found two little rings of beaten gold and a saw of pure copper. In the Ashmolean Museum there are a very ancient silver ball, and beads of the same metal rolled from the flat; also a spear-head of copper. These were obtained from Amorgos. In Antiparos there have also been found very ancient objects of silver mixed with copper.

Passing to the mainland, the towns of the Peloponnesus and the mound of Hissarlik, the supposed Troy, have been explored by Dr. Schliemann, Dr. Tsountas, and Dr. Dorpfeld; and they reveal what is termed the Mycenæan period, which figures so largely in the poems of Homer and Hesiod. In these the precious metals, gold and silver, are constantly mentioned, together with *χαλκος*, generally translated brass. Thus, in the description of Achilles' shield, we are introduced to Hephaistos at his great forge on Etna, heating the bars of silver, or brass, or tin, or gold, and then hammering them on the anvil, so forming the designs which represent so beautifully the various scenes of peace and war. After having fashioned the shield, he is represented as forging for the warrior a cuirass of copper, greaves of tin, and a helmet with a golden crest.

Homer frequently mentions iron, but generally gives it the epithet "worked with toil," and treats it as a rare and costly metal. Thus a huge iron discus was given as a valuable prize to the hero who could throw it the farthest in the athletic games at the funeral of Patroclus.

Mr. W. E. Gladstone, who has long turned the great powers of his mind from time to time to Homeric studies, wrote me last summer: "The poems of Homer showed me, I think, forty years ago that they represented in the main a copper age." The reasons he assigns in his letter, as well as in his published works, are fairly conclusive, and the recent explorations, and the analyses of Dr. Percy, Prof. Roberts-Austen, and others, have shown that in the early period of the Mycenæan age copper without tin was employed for numberless purposes; but as time advanced, bronze came into use. At Hissarlik, in the lowest and second city have been found a gilded knife-blade, needles and pins, of practically pure copper; while in the third and sixth cities occur battle-axes of copper containing 3 to 8 per cent. of tin. In the very old town of Tiryns, the palace apparently had its walls covered with sheets of copper; much lead was also found there. At Mycenai, the Achaian capital, the metals in use were gold, silver, copper, bronze and lead; copper jugs and cauldrons are common, and great leaden jars for storing grain; also elegant bronze tools and cutlery; mirrors, razors and swords. In the tombs the bodies are laden with jewels, largely ornaments of gold, with a much smaller amount of silver.

Some of these objects illustrate the poems of the time; thus, in the Odyssey we find Nestor making a vow to Athenæ: "So the heifer came from the field; . . . the smith came holding in his hands his tools, the means of his craft, anvil and hammer, and well-made pincers, wherewith he wrought the gold. Athenæ, too, came to receive the sacrifice. And the old knight Nestor gave gold, and the other fashioned it skilfully, and gilded therewith the horns of the heifer, that the goddess might be glad at the sight of her fair offering." Now at Mycenai there was found the model of an ox-head in silver, with its horns gilded, and between them a rosette of gold, not directly attached to the silver, but to a thin copper plate. In Vaphio, a town near Sparta, of a somewhat later period, tombs were found containing many beautiful objects in silver, gold and bronze. Especially noteworthy are two golden cups embossed with figures of bulls and men; in the one case it is a spirited hunt in the woods, in the other a peaceful scene on the meadows. Iron, in Mycenai, appears only as a precious metal of which finger-rings are formed.

In the remains of a Greek colony in Cyprus, belonging to the end of the Mycenæan period, which is now being explored by the British Museum, iron plays a much more important part. At Athens also large iron swords, which belonged to the ninth or tenth century B.C., have been found in an old cemetery.

After this came the intellectual period of Grecian history. Aristotle must be mentioned in any account of the science of the day; and he it is who gives us the first description of the metal mercury, and also how to produce the alloy which we call brass, by heating together copper and calamine, the carbonate of zinc. Metallic zinc, however, was not known for many centuries afterwards.

CONCLUSION.

In tracing back the history of these great nations we have found evidence of a time when metals were little, if at all, employed: the potter's art was well known, and early man became wonderfully proficient in working hard stone, and especially flint. The earliest indications we have of metals are of gold and copper, both being scarce, and no doubt costly. Gold was probably the earliest to attract the attention of mankind, because it occurs native, of bright yellow colour, and is easily worked. Copper, however, dates to a similar period, so far as the remains which have come down to us are concerned. Probably the deep blue carbonate, such as occurs in Armenia, was first worked. When silver was first used is not very evident, but it is certain that it was far more common in the northern portion of the area we have been considering, than in the southern. The metallurgy of copper was doubtless a matter of much study and experiment, so as to produce the hardest metal. This seems to have led to the discovery of tin, but at what precise period we know not; nor do we know whether it was brought from Etruria, or found in some nearer region. Mines of tin were certainly worked at Cento Camarelle, as Egyptian scarabs have been found in the old workings,[1] and near Campiglia and in Elba, as well as in the Iberian peninsula. This search for the metals, and the necessity of carrying the ore or rough metal to the places where it was wrought, or of the finished material to distant customers, must have greatly promoted commerce. This took place both by land and sea, in caravans and ships. In this way tools and other objects were disseminated through the more distant parts of Europe and Asia: the similarity of type over large areas shows a common origin, and hence we can even roughly form an opinion as to whether they were introduced in earlier or later times. Thus, in Switzerland and Scandinavia we meet with copper implements as well as bronze, and ancient as well as modern forms; while in Britain we find no evidence of copper tools, though bronze objects are abundant.

The Phœnicians, arriving on the eastern shores of the Mediterranean from the direction of the Persian Gulf, formed an important nation for about 1000 years, from B.C. 1400 to B.C. 400. They were great artificers, but not having much originality they adopted the patterns and designs of Egypt or Assyria. They were also pre-eminently traders, and founded cities and emporia of commerce, so that their metal work was spread over all the Mediterranean. It is to be found in Cyprus, mixed with the workmanship of the Grecian Mycenæan age. Their ornamental jewellery was eagerly sought in Etruria, Greece and Calabria; for the beauty of it I may refer you to the Etruscan cup of gold in the South Kensington Museum, and the wonderful work in gold in one of the Greek rooms in the British Museum.

Commerce implies a large extension of a medium of exchange. The whole question of money is far too wide a subject for us to deal with now; suffice it to say that Herodotus attributes to the Lydians the introduction of the use of coins. The earliest were of electrum, issued in the form of oval bullets, officially stamped on one side. They date back, perhaps, to B.C. 700; but according to other authorities, silver money was coined at Ægina more than a century before that time.

The great period which has been under our consideration terminated in each conntry with an age of disorder and deterior-

[1] See "Early Man in Britain," by Prof. W. Boyd Dawkins.

ation. The rise of the Roman Empire introduced a new era: it was in one sense an iron age—*ferrum* being synonymous with the sword. We now live in another kind of iron age, but in better and brighter times than those of Hesiod, and we may hope that our great engineering works, our iron roads and iron steam-ships may lead not to the enslaving but the brotherhood of nations.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MISS JANE CRUIKSHANK has given 15,000*l.* to Aberdeen University, to provide a botanic garden at Aberdeen in memory of the late Dr. Alexander Cruikshank.

THE University of Edinburgh has conferred the honorary degree of LL.D. upon Mr. Horace T. Brown, F.R.S., Prof. D. G. Ritchie, and Prof. J. Victor Carus, assistant professor of zoology at Leipzig.

IN order to make accessible under the most favourable conditions to university students, to teachers, and to investigators, the facilities and environment of the Illinois Biological Station, reinforced by the equipment of the biological departments of the University of Illinois, the university has decided to open, on June 15, a summer school of field and laboratory biology at this station on the Illinois River, at Havana. Opportunity is thus given for personal studies, in field and laboratory, of the plants and animals of a peculiarly rich and interesting situation, and of the methods of modern biological station work.

THE following are items concerning the extension of provision for scientific training in the United States:—Syracuse University will shortly begin the erection of a 45,000-dollar science building.—Adelbert College at Cleveland, Ohio, has a biological building under way, which will cost about the same amount.—Richmond College, Virginia, has received 5000 dollars towards a science building.—The University of Chicago has received a gift of about 150,000 dollars from an anonymous donor. Miss Gould has given a further sum of 10,000 dollars towards the endowment of the engineering school of New York University.—Mr. Chester W. Kingsley has given 25,000 dollars to Colby University.

IT was briefly noted last week that the University of Paris had taken up a loan amounting in all to 1,700,000 francs. Referring to this action, the Paris correspondent of the *Lancet* remarks:—The law which has reconstituted the universities has given to them a civil personality; they have their own budget and their own sources of income, which are definite and assured, and they are able to contract loans on the security of these sources of income. The 1,700,000 francs which the university has borrowed will be devoted to carrying out two schemes. The greater part of this sum will be devoted to the construction of buildings for the accommodation of first-year students in medicine. The other portion of the loan will be devoted to the keeping-up of a laboratory of natural history at Fontainebleau.

THE Technical Education Board of the London County Council will proceed shortly to award not less than five Senior County Scholarships. These scholarships are of the value of 50*l.* a year, together with the payment of tuition fees up to 30*l.* a year, and are tenable for three years at university colleges and advanced technical institutes. They are confined to residents within the administrative county of London, and are open only to those whose parents are in receipt of not more than 400*l.* a year. Candidates should as a rule be under twenty-two years of age, though the Board reserves the right to give preference to candidates who are under nineteen years of age. The scholarships are intended to encourage more especially the teaching of science, and to enable those students who cannot afford a university training to pursue advanced studies for a period of three years in the highest university institutions in this country or abroad. Of the seventeen students who are now holding Senior Scholarships five are studying at Cambridge, five at the Central Technical College in Exhibition Road, three at the Durham College of Science, Newcastle-upon-Tyne, two at German Universities, and two (ladies) at Bedford College and Holloway College respectively. The scholarships are awarded on a consideration of the past record and general qualifications of the candidates, and not upon the results of a set examination. Application forms may be obtained from the Board's Secretary, 116 St. Martin's Lane, W.C., and must be returned not later than Monday, May 16.

DURING his term of office, Sir A. Mackenzie, the Lieutenant-Governor of Bengal, has done much to advance the cause of scientific and technical education in his province, and a speech he delivered recently at the Indian Association for the cultivation of science is a further expression of his sympathies with the development of education on scientific lines. In the course of his address he said:—"I would have the student of the future cease to be brought up on badly assimilated *words* and on high-faluting rhetoric, and I would have him taught to observe and think, and *educate himself* in the way Herbert Spencer indicates as the great desideratum in all education. The oriental mind is only too prone to rest on authority and accept inaccuracies. Pupils trained on books and books alone are mere passive recipients of other people's ideas. They never learn the arts of observing facts and applying knowledge. The study of science cultivates the judgment as the study of language never can. Science constantly appeals to and develops the individual reason. It is no doubt the case that even in England people are only now waking up to the knowledge of a wise pedagogy, but they *are* waking up at last. The idea of development of faculty is being substituted for that of mere acquisition of knowledge. The mere cultivation of words and application of formulæ is being discredited. The ideal education is being recognised as one which multiplies the power of the eye to see, of the ears to hear, of the hand to execute; which puts a mind well stored with knowledge into active contact with faculties capable of translating it into action." In India at present science holds but a very secondary place in the curriculum of high education, and if the country is ever to advance there must be an educational revolution which will release the youth of India from the bonds of a purely literary education. The University of Calcutta has as yet done little for science culture, but the Bengal Government has within the last few years done good work for the advancement of technical education. The reconstruction of the Medical College begun by Sir Charles Elliott has been pushed on; and the Sibpur Engineering College has been expanded so as to make it a school where civil engineering, mining engineering, mechanical engineering, and electrical engineering can be and are being thoroughly taught to over 300 students. The Presidency College, having as principal Prof. A. Pedler and upon its staff Profs. J. C. Bose and Roy, has also admirable work to show. Sir A. Mackenzie concluded by saying: "As the Bengali has conquered the field of medicine, so he may conquer the field of engineering and mechanical industry, if those engaged in the instruction of the young will only shake themselves free from the trammels of a literary curriculum which, coupled with the absence of moral and religious training and the failure to impart a sound knowledge of their own country, its material wants and capabilities, is in my judgment fast ruining the youth of the country and stunting their development."

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, March.—The relations of analysis and mathematical physics is the translation, by C. J. Keyser, of the interesting address delivered before the International Congress of Mathematicians, at Zürich, on August 9, 1897. The writer, Prof. H. Poincaré, answers some questions which he says are often asked, as "What is the utility of mathematics, and whether its nicely constructed theories, drawn entirely from the mind, are not artificial products of our caprice?" "The end of mathematical physics is not merely to facilitate the numerical calculation of certain constants, or the integration of certain differential equations. It is more; it is, above all, to disclose to the physicist the concealed harmonies of things by furnishing him with a new point of view."—The roots of polynomials which satisfy certain linear differential equations of the second order, is a short note by Prof. M. Bôcher, following up work by Stieltjes in vol. vi. of the *Acta Mathematica*.—Inflexional lines, triplets, and triangles associated with the plane cubic curve, by Prof. H. S. White, considers the configuration of the nine inflexions of a non-singular plane cubic and the twelve lines containing them 3 and 3, from what the writer thinks to be a novel point of view. The statements are of some interest.—On the intersections of plane curves, by Prof. Charlotte Scott, brings together several passages bearing on Maclaurin's paradox (*i.e.* Cramer's so-called, but it is here carried back to Maclaurin). It is a valuable paper on curves.

and is mainly concerned with a recent paper by F. S. Macaulay, viz. point groups in relation to curves (*London Math. Soc. Proc.*, vol. xxvi. pp. 495–544).—Prof. Beman points out the use of i, by Euler, to represent an imaginary, thus disposing of Gauss's claim to priority.—The remaining matter consists of shorter notices (*i.e.* reviews), notes, and publications.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 10.—"An Extension of Maxwell's Electro-magnetic Theory of Light to include Dispersion, Metallic Reflection, and Allied Phenomena." By Edwin Edser, A.R.C.S. Communicated by Captain W. de W. Abney, C.B., F.R.S.

All media are considered, as far as their properties affect the propagation of electro-magnetic waves of frequencies as great as those of light, to consist of molecules, each comprising, in the simplest case, two oppositely charged atoms at a definite distance apart. In an electric field the positive atoms move to points of lower, and the negative atoms to points of higher potential. In doing so a molecule may be subjected to a rotational displacement, or its constituent atoms may be separated more widely from each other. Equations are determined giving the relation of the specific inductive capacity (the electric strain being steady) to the molecular displacements.

Maxwell's well-known equations are modified by adding to the total displacement current a term representing the convection current per unit volume. The existence of free ions is not considered capable of materially affecting the value of the refractive index for light waves. Subsidiary equations representing the conditions of the atomic vibrations are assumed, and the refractive index, μ, is finally given by the equation

$$\mu^2 = \mu_\infty^2 + \frac{c'\lambda_1^2}{\lambda^2 - \lambda_1^2} + \frac{c''\lambda_2^2}{\lambda^2 - \lambda_2^2}$$

μ_∞^2 represents the specific inductive capacity as previously determined.

Double refraction in a uniaxal crystal is explained by supposing the axes of the molecules to be arranged with their axes all parallel to one direction. Electric disturbances perpendicular to this direction will produce a molecular rotation, whilst those parallel to the molecular axes will produce a separation of the constituent atoms. Hence two different propagational velocities will follow. The connections of the above theory with Kerr's well-known experiments on the double refraction experienced by light when traversing a liquid dielectric subjected to electric stress, and the facts of pyro-electricity are obvious.

In order to account for the phenomena of the propagation of light in metals, a viscous term is added to the equation for the molecular vibrations. The square of the refractive index is hence derived as a complex quantity, the imaginary part being essentially positive. In those cases where the real part of the refractive index is a large negative number, it is pointed out that the velocity of propagation of light waves will be inversely proportional to the molecular viscosity (and therefore to the electrical resistance) of the metal, agreeing with Kundt's experimental relation.

Geological Society, April 6.—W. Whitaker, F.R.S., President, in the chair.—Prof. T. Rupert Jones exhibited and commented upon a series of large stone implements, sent to England by Mr. Sidney Ryan, from the tin-bearing gravels of the Embabaan in Swaziland (South Africa). Some implements lent by Mr. Nicol Brown, and analogous implements of rough quartzite, from Somaliland, lent by the Rev. R. A. Bullen, were also exhibited.—Prof. H. G. Seeley exhibited the humerus of a Plesiosaurian in which the substance of the bone was almost entirely replaced by opal. He explained that the fossil was from the opal mines of New South Wales.—On some Palæolithic implements from the plateau-gravels, and their evidence concerning "Eolithic" man, by W. Cunnington. Although at first inclined to believe that the chipping on the "Eoliths" of the plateau-gravels was the work of man, the author has been led to recant this opinion by the detailed study of specimens lent or given to him by Mr. B. Harrison. His reasons are mainly based on the facts that the chipping is of different dates, even upon the same specimen, and that it was produced after the specimens were embedded in the gravel. A further series of specimens, which, although not found actually *in situ* in the gravels, present undoubted evidence that they came from these, are considered by the author to be of Palæolithic type. One of them appeared to have gone through the following stages: first it was fashioned by man into a Palæolithic implement, then it was abraded, broken and chipped along one edge in the same fashion as the alleged "Eolithic" working; finally it was stained, marked with glacial striæ, and covered with a thin layer of white silica. This implement appears to prove that Palæolithic man lived on the Kentish plateau before or during the deposit of the plateau-gravels, and that the "Eolithic" chipping is not the work of man. A long discussion followed the reading of the paper, and was summed up by Dr. Gregory, who replied on behalf of the author. Dr. Gregory said he noticed in the discussion absolute unanimity on one point: no one denied that some of the specimens exhibited were worked by man, and that they were genuine plateau-gravel flints, which must have been flaked before the deposition of the gravels. Every speaker had therefore admitted that man lived in Kent before or during the deposition of part of the plateau-gravels. Thanks, therefore, to Mr. B. Harrison's magnificent perseverance and industry, man's age in Kent had been carried back one stage further. In the congratulations to Mr. Harrison on that achievement, no one would join more heartily than the author. But that admission did not affect the question of the specimens described as "Eoliths" or "rudes." Those who believed in these specimens still could not agree as to which are genuine and which are not. He thought the critical points of the paper had been ignored in the discussion: no attempt had been made to show that the implements were not Palæolithic, or that the "Eolithic" work was not later than the Palæolithic work. He quoted the opinions of Mr. Montgomery Bell and Mr. Harrison to show the identity of the working of the broken edge of the Palæolith with that of the Eoliths. It was only the "Eolithic" implements that the author had denied. The wide general importance of this question was the claim that the Kent plateau had been the home of a primitive pre-Palæolithic people, which, he held, the author's arguments conclusively disproved.—On the grouping of some divisions of Jurassic time, by S. S. Buckman. The author argues for an arrangement in the division of Jurassic time based upon the zoological phenomena of the Ammonite fauna.

PARIS

Academy of Sciences, April 12.—M. van Tieghem in the chair.—The President announced to the Academy the recent death of M. Aimé Girard, Member of the Section of Rural Economy (see p. 587).—Observations relative to the action of oxygen upon sulphide of carbon and to the chemical influence of light. Preliminary action determining the chemical changes, by M. Berthelot. In a mixture of air with the vapour of carbon disulphide exposed to diffused light no change was found to have occurred at the end of a year. Under the influence of direct sunlight, however, oxidation soon commences, but is by no means completed in a year. The effect produced is, therefore, not simply proportional to the luminous intensity, unlike the combination of hydrogen and chlorine, which commences in the most feeble diffused light and increases with the intensity.—On the absorption of oxygen by pyrogallate of potassium, by M. Berthelot. The principal defect of the common method of estimating oxygen consists in the simultaneous formation of small quantities of carbonic oxide. A number of experiments are described in which the influence of temperature, dilution, and the relative proportions of pyrogallol and potash upon the course of the reaction is ascertained. The author concludes that, in order that only negligible quantities of carbonic oxide may be produced, the absorption should be effected in presence of a large excess of potash and an amount of pyrogallol capable of absorbing four or five times the volume of oxygen likely to be present. From the products of the reaction an oxyquinone ($C_6H_4O_5$) may be extracted with ether, after acidification. This compound will be described later.—Flesh and starch compared with sugar, as regards nutritive value, in the case of a working subject, by M. Chauveau.—Addition to a preceding communication concerning the theory of quadratic forms, by M. de Jonquières.—Observations of Comet Perrine, made at the observatory of Algiers, by MM. Rambaud and F. Sy.—Expression of the derivatives of *theta* functions of two arguments by means of the squares of *theta* functions, by M. E. Jahnke.—On the systems of differential equations satisfied by quadruply periodic functions of the second species, by M. M. Krause.—On the equations of the theory of elasticity, by MM. Eugène and François Cosserat.—On the passage of electric waves from

one conductor to another, by M. C. Gutton.—On the thermic properties of saturated vapours, by M. E. Mathias.—On a new apparatus for the raising of liquids, by M. G. Trouvé. The instrument combines the principles of the centrifugal pump and the water-spout. The liquid is given a gyratory or spiral motion by means of a revolving cone, from the larger end of which it is expelled through an orifice placed tangentially.—On the plane of magnetisation of magnetic pyrites, by M. Pierre Weiss. When a magnet is brought near a crystal of the mineral no attraction is observed when the plane of the hexagonal base is perpendicular to the lines of force, although it is very marked in any other position. Exact experiments are adduced to prove that magnetisation can only take place in one plane, the *magnetic plane*.—Rays emitted by compounds of uranium and of thorium, by Mme. Sklodowska Curie. A study of the influence of the rays emitted by various compounds of the two metals upon the conductivity of the air. A difference of potential of 100 volts was established between the two plates of a condenser (at a distance of 3 centimetres), one of which was covered with a uniform layer of the substance under examination. The current strength was measured by means of an electrometer. All the compounds of uranium and thorium are active; those of cerium, tantalum, and niobium but slightly so. Two minerals of uranium, viz. pitchblende (oxide of uranium) and chalcolite (phosphate of copper and uranyl), are much more active than uranium itself. It is to be observed that the most active elements, uranium and thorium, are those which have the highest atomic weights.—On a means of augmenting the intensity and the rapidity of action of the X-rays, by M. F. Garrigou. The rays are confined during their passage from the source to the fluorescent screen or photographic plate by a cylinder of glass or metal. They are thus concentrated, and produce the required effect in a shorter time.—On the combinations of pyridine and trimethylamine with formic and acetic acids, by M. G. André. The compounds of pyridine described in a previous communication have been further investigated, and their heats of formation determined. They were found to be completely dissociated on vaporisation. Similar compounds of trimethylamine have now been prepared, and found to be more stable than the corresponding pyridine derivatives.—Influence of wave movements upon the development of the larvæ of the frog, by M. Émile Yung. The eggs of batrachians are naturally deposited in the calm waters of marshes and lakes. The author has studied the effect of continual agitation on their development. The freshly fertilised eggs speedily die; but if the embryo be already formed before agitation commences, development continues, although the mortality is great. The surviving tadpoles are distinguished by horny formations in the buccal cavity and a remarkable development of the tail.

DIARY OF SOCIETIES.

THURSDAY, April 21.

Society of Arts (Indian Section), at 4.30.—Recent Railway Policy in India: Horace Bell.

Linnean Society, at 8.—On the Structure of *Dendroceros*: Prof. Douglas Campbell.—On the Pterylosis of the Owls: W. P. Pycraft.—On the Thymus and Thyroid of Marsupials: J. Johnston.

Institution of Electrical Engineers, at 8.—Cost of Generation and Distribution of Electrical Energy: R. Hammond. (Continuation of Discussion.)

Chemical Society, at 8.—The Carbohydrates of Barley Straw: C. F. Cross, E. J. Bevan, and Claud Smith.—Isomeric Bornylamines: Dr. M. O. Forster.—Some Derivatives of Benzophenone: Dr. F. E. Matthews.—Researches on Camphoric Acid: Dr. S. B. Schryver.—Ballot for Election of Fellows.

FRIDAY, April 22.

Royal Institution, at 9.—The Recent Eclipse: W. H. M. Christie, C.B., F.R.S.

Physical Society, at 5.—On a Method of Viewing Newton's Rings: Rev. T. C. Porter.

Institution of Civil Engineers, at 8.—New Cut Swing Bridge, Swansea: M. W. Henty.

SATURDAY, April 23.

Geologists' Association (Paddington Station, at 1.33).—Excursion to Reading. Director: J. H. Blake.

MONDAY, April 25.

Society of Arts, at 8.—Sources of Commercial India-rubber: Dr. D. Morris, C.M.G.

Royal Geographical Society, at 8.30.—Investigations in the Atlantic: H.S.H. the Prince of Monaco.

Institute of Actuaries, at 5.30.—On the Mortality in the British Navy and Army, as shown by the Official Reports: James J. McLauchlan.

TUESDAY, April 26.

Anthropological Institute, at 8.30.—Exhibition of Stone Implements from Swazieland, South Africa: Prof. T. Rupert Jones, F.R.S.—Exhibition of Stone Implements from South Africa: W. H. Penning.—A Study of African Crania: Frank C. Shrubsall.

Institution of Civil Engineers, at 8.—Annual General Meeting of Corporate Members.

Royal Horticultural Society, at 1.—Sweet-scented Leaves.

Royal Victoria Hall, at 8.30.—Motor Cars: Prof. D. S. Capper.

WEDNESDAY, April 27.

Society of Arts, at 8.—Photography and Colour Printing: Captain W. de W. Abney, C.B., F.R.S.

Royal Geographical Society, at 4.30.—The Possibility of Acclimatisation of Whites in Tropical Countries: Dr. Sambon.

Institution of Mechanical Engineers, at 7.30.—President's Address: S. W. Johnson.—First Report to the Gas-Engine Research Committee; Description of Apparatus and Methods, and Preliminary Results: Prof. Frederic W. Burstall.—Supplementary Paper and Adjourned Discussion.

THURSDAY, April 28.

Royal Society, at 4.30.

Institution of Electrical Engineers, at 8.

FRIDAY, April 29.

Royal Institution, at 9.—Magneto-Optic Rotation and its Explanation by a Gyrostatic Medium (with Experimental Illustrations): Prof. A. Gray, F.R.S.

Institution of Mechanical Engineers, at 7.30.—Steam Laundry Machinery: Sidney Tebbutt.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Radiography and the "X" Rays: S. R. Bottone (Whittaker).—The Theory and Practice of Electrolytic Methods of Analysis: Dr. B. Neumann, translated by J. B. C. Kershaw (Whittaker).—Alternate Currents in Practice: translated from the French of Loppé and Bouquet by F. J. Moffett (Whittaker).—A Manual of Dental Metallurgy: E. A. Smith (Churchill).—A Manual of Dental Anatomy: C. S. Tomes, 5th edition (Churchill).—Musical Statics: J. Curwen, new edition, revised by T. F. Harris (Curwen).—A Student's Text-Book of Zoology: A. Sedgwick, Vol. 1 (Sonnenschein).

Pamphlets.—Tobacco Soils of the United States: M. Whitney (Washington).—Die Meteorologie der Sonne und das Wetter im Jahre 1888: Prof. K. W. Zenger (Prag).—Recent Laws against Injurious Insects in North America: L. O. Howard (Washington).

Serials.—Engineering Magazine, April (222 Strand).—Scribner's Magazine, April (Low).—Annales de Electrobiologie, &c., March (Paris, Alcan).—American Journal of Science, April (New Haven).—Record of Technical and Secondary Education, April (Macmillan).—Journal of the Institution of Electrical Engineers, April (Spon).—Terrestrial Magnetism, March (Cincinnati).—Journal of the Royal Statistical Society, March (Stanford).—Geographical Journal, April (Stanford).—Encyklopædie der Naturwissenschaften, Erste Abthg. 71, 72 Liefg., Dritte Abthg. 38 to 43 Liefg. (Breslau, Trewendt).—Zoologist, April (West).—Quarterly Journal of Microscopical Science, March (Churchill).—Journal of the Royal Horticultural Society, April (117 Victoria Street).—Journal of the Franklin Institute, April (Philadelphia).

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THURSDAY, APRIL 28, 1898.

BACTERIOLYSIS OF SEWAGE.

The Purification of Sewage and Water. By W. J. Dibdin, F.I.C., F.C.S., &c., late Chemist and Superintending Gas Examiner to the London County Council and the late Metropolitan Board of Works. Pp. xv + 248. Royal 8vo. (London: The Sanitary Publishing Company, Ltd., 1897.)

RECENTLY there has been an astonishing and sudden revival of interest in the question of the action of bacteria on dead organic matter. Pasteur's experiments on the production of disease by morbific germs were so brilliant that, for long, most workers at the subject kept very much in one groove; still there have always been those who, working very quietly, have been accumulating knowledge concerning the action of bacteria on dead material, and the part these organisms play in the process of disintegration of effete matter.

It has, however, long been known that in nature various processes of purification were undoubtedly intimately associated with the life-history of special groups of bacteria. Certain of these organisms, moreover, have been recognised as playing a most important part in bringing organic material into such condition that it may be readily oxidised; and in both France and England investigators have studied this action, especially in connection with the organisms that are associated with the process of nitrification. It is somewhat remarkable that notwithstanding these numerous experiments, and in spite of the fact that the importance of the part which bacteria play in bringing about natural decomposition, nitrification and similar chemical processes had been so early recognised, no systematic attempt on any large scale had until comparatively recently been made to carry out, artificially, what was recognised as being done on a most extensive scale in nature's laboratory. When once, however, a commencement had been made, the course of events was by no means slow, and many investigators soon turned their attention to the question of the disintegration of the organic matter in sewage, its oxidation and "mineralisation." Amongst these later workers, Mr. W. J. Dibdin has taken an important position, and, in connection with his office as chemist to the London County Council, carried on a series of experiments on the bacterial purification of sewage, which in future will certainly be looked upon as constituting one of the most important parts of the pioneer work on the subject that has been carried out in this country. As the outcome of this work, Mr. Dibdin has published in book form a collected series of articles on the purification of sewage and water; and for those who wish to obtain, in clear and concise form, an account of certain of the bacteriological processes involved in this purification, and who wish to have a summary of the chemical changes and results obtained, no better book is at present published. Now that the question is looked upon as of sufficient importance to demand the appointment of a Royal Commission, to assist the Local Government Board to gather information, some such book as that now before us comes very opportunely. It is fortunate, indeed, that the task of supplying such a book has been undertaken by one whose knowledge of the chemical processes involved is of a very wide and practical character, who has a fair knowledge of the essential details of bacteriology, but who, more important still, has had a very wide experience of the actual working of biological filters. The mass of material accumulated in this book does not at first sight appear, as the conclusions are usually so pithily put, and in such simple language, that the enormous amount of work and systematic observation on which they are founded is sometimes almost lost sight of.

In order to convey some idea of the scope of this work, it may be well to give a brief outline of the ground covered by Mr. Dibdin. After a couple of introductory chapters on the "history of putrefaction" and of the attempts that have, from time to time, been made to interfere with the process of putrefaction in sewage and in river-water, and after describing in some detail the various processes of disinfection, deodorisation, precipitation, and ordinary filtration, a short description of the now famous Massachusetts experiments is given. Then follows a very full account of a series of experiments carried out on the purification of London sewage in biological filter-beds at Barking, and the nature and amount of purification brought about in these filter-beds indicated, the measurement of the purification being taken (*a*) from the amount of oxygen absorbed; (*b*) from the amount of albuminoid ammonia got rid of; and (*c*) the increase in the quantity of nitrates. By passing the sewage intermittently through these filters, and by allowing them to rest and become aerated between the charges, it was found that a purification of from 41 to 85 per cent. was obtained; the whole of the organic matter in suspension was completely removed, and an effluent, in most cases fit to be sent into rivers, was obtained. This purification goes on at the rate of about three-quarters of a million gallons per acre of biological filter.

An installation at Sutton was worked on somewhat similar lines, but here the filtrate from one bacteria tank was passed through a second, in which the filtering material was of finer grain; by this means still better results were obtained, 80 per cent. of purification being about the average obtained. The final filtrates were free from all objectionable odour, and remained perfectly sweet on being kept in either open or closed vessels. At both Barking and Sutton the coarse suspended matter was strained out and buried, and the whole of the subsequent changes were supposed to be due to the action of aerobic organisms.

Mr. Dibdin then gives a description of a system which has been worked out by Scott-Moncrieff at Ashstead, and by Cameron at Exeter, who both use an anaerobic chamber in order to initiate an active preliminary breaking-down of the organic matter in the sewage before aerobic organisms are allowed to act upon it. They hold that in this way a more active disintegration of the organic matter is obtained; whilst, in addition, a process of peptonisation is carried on, with the result that a large quantity of the solid material is quickly thrown into solution, in which form it can be

more readily acted upon by aerobic organisms. It is evident, from the description given and comments made by Mr. Dibdin, that he pins his faith to the aerobic method; though, from the evidence given, it seems probable that the author may in time come to modify his present position.

One of the most interesting sections in the book is that devoted to the description of the various methods by means of which Mr. Dibdin has obtained his results. The description of the micro-filter alone would well repay a perusal of the whole book; the ingenuity exhibited in this simple piece of apparatus marking out Mr. Dibdin as, if not a born, a well-trained experimenter. The methods of determining the amount of nitrates and of oxygen absorbed and dissolved, will appear to the ordinary reader to be considerably less complex and complicated than those usually recommended. This is due, in part, to the fact that some of the processes have undoubtedly been simplified; but it is due still more to the fact that, having worked so much with them, Mr. Dibdin is able to give clear and lucid descriptions of the essential parts of the process without overburdening them with details which, from a practical point of view, are of little importance.

A full description is given of the history of the purification of the Thames from the time that the reaches between Westminster and Waterloo Bridges had their banks covered with accumulations of offensive mud, deposited from water little better than sewage, to the time that fish made their way up the ditches which contained the effluent from the biological filter-tanks at Barking. The whole story is one of engineering, chemistry and bacteriology, set out in plain matter-of-fact form; but Hercules' task of cleansing the Augean stables was mere child's play to the problem that had to be attacked and solved between the years 1855 and 1895. The concluding chapters of the book are taken up with descriptions of some of the methods of ventilation and deodorisation of sewers; with a short account of filtration of potable water; a description of the character of the London water supply; with sections on the action of soft water upon lead; on the application of the biological process to the purification of waste water from private properties, asylums, schools, &c.; and, finally, one on the systematic examination of potable water. Appendices on methods of determining the amount of oxygen dissolved in water, and a detailed report to the London County Council on the experiments on the filtration of sewage effluent during the years 1892-95 complete the work.

Although the reader may not, and probably will not, always agree with Mr. Dibdin, the work on which the conclusions are based appears, in most cases, to be above criticism. The experiments are set out in such form that each one affords ample material on which to base an opinion; the statistics, observations and descriptions are of such a character that not only will they assist in this, but they also give evidence that Mr. Dibdin has made the subject thoroughly his own. His arguments are backed by facts and figures, all the results of careful investigation and of laborious work. The result is that we have a book of far more than ordinary interest, quite apart from the fact that the author has to deal with such interesting matter—a book that may with confidence be recommended to any who take an interest, however slight, in the subject of the bacterial treatment of sewage.

G. S. W.

SCIENCE AND ART OF BUILDING.

Modern Architecture. A book for architects and the public. By H. H. Statham, F.R.I.B.A., Editor of the *Builder*, &c. 8vo, pp. 275. (London: Chapman and Hall, 1897.)

Complete Perspective Course. Britannia Series. By J. Humphrey Spanton. 8vo, pp. 282. (London: Macmillan and Co., 1898.)

Notes on Carpentry and Joinery. By Thomas Jay Evans. 8vo, pp. 396. (London: Chapman and Hall, 1897.)

THE first of these three books suffers from the too prevalent custom of assigning a title to a book that conveys the idea of a greater scope and value than the contents can candidly be said to justify. In the preface the author fairly states the origin of the bulk of the book in a course of lectures delivered to a class of architectural students, not, it is true, previously published, but which, we venture to think, should have appeared in their primary form, possessing all the interest and actuality that such deliverances would have had; without being dressed up with a title that leads the reader to expect a more serious treatment of such an extensive subject as modern architecture.

There are undoubtedly many cultivated people to whom a clear account of modern architecture would be of the greatest interest, inquirers who from time to time, lighting upon some fine modern building, have been puzzled at the qualities which they have felt it to possess, but which are not, at the same time, those of ancient buildings with which the antiquarian leanings of most English people of taste might have made them familiar. Thus made dimly conscious of a new spirit in architecture, they have felt a novel ignorance of the aims and ideals of a modern art, of which very likely they had not been prepared to admit the existence.

A layman is heard to ask an architect, "What style do you call the Imperial Institute?" or "Who was the architect of that fine church of St. Augustine's, Kilburn, which I happened to see the other day?" and so on—questions that show how absolute an ignorance of the development of the architecture of the present day exists even in cultivated circles.

It is to this class, we imagine, that the author intends to appeal as the public mentioned in his title; but the circumstances of the origin of his book in lectures of the kind mentioned above, tells altogether against its usefulness in that respect. It contains a great deal of criticism that was sufficiently useful when directed to the students to whom the lectures were given, but which is out of place in a work addressed to a special class of the public outside.

Again, the author's position as editor of the *Builder* placed at his command a large supply of illustrations for these lectures from the plates of his own journal,

which are here given in a much reduced, and consequently very poorly executed, form; but though the *Builder* retains the leading position amongst architectural papers, it cannot by any means be held to be a fully representative depository of the modern architecture even of England.

Very many of the best buildings never are illustrated at all, either because the architects do not care to publish, or else do not take the trouble to have elaborate drawings made solely for publication; while, on the other hand, there is a flood of second-rate work that is given to the world for obvious commercial reasons.

To rely upon the illustrated journals for a knowledge of modern work is as hopeless as the proceedings of an American critic, who in all good faith tried riding down the main streets of the metropolis on the top of an omnibus, in the expectation of forming an impression of the quality of modern architecture in London.

For a book with this title, the subjects illustrated are too incomplete for it to possess the scientific value that a comprehensive treatise would contain, and in the letterpress the same inadequacy prevails.

The best section is that on State and municipal architecture, the subject that seems to have the greatest interest for the author; but that on the highly important question of domestic work is only slightly treated, and that on church architecture is on lines which, we feel, would hardly be endorsed by those to whom the greatest progress in this branch, in modern times, has been due.

This is not the only section in which the tone of the work is unfortunate. The style in which it is written is hasty and journalistic, and we do not quite like the writer's method of making points by quoting what appears to have been said to him in private conversation, where views are apt to be expressed with a greater vivacity, not to say exaggeration, than the speaker would use in the more deliberate statement of writing.

The truth is, that there is no royal road or cheap handbook to a knowledge of modern architecture. The serious student must hunt up the buildings for himself, even if they are five miles from a railway station. The performances of a great architect are seldom known until his death, and perhaps not even then. The public have no knowledge of Nesfield, Devey, or Bentley, to take three names at random—none of whom, by the way, are mentioned in this book—except that, as regards the last, the writer seems to think that because the new Roman Catholic cathedral drawings have not been given to the *Builder*, that therefore "it is a design about which there is a great reluctance to give any definite information"; a very amusing remark in view of the fact that students interested in the matter have long ago bought copies of a publication in which the scale drawings and full particulars of this remarkable design have been given.

The book on perspective is one of those innumerable works that the modern craze for examination produces; it is designed to meet, as quoted on the title-page, the requirements of four examining bodies, and as the author is instructor to the Royal Naval cadets on the *Britannia*, he has the necessary teaching experience to make his work likely to be helpful to the unlucky souls condemned to these examinations. To the architect, for whom also the book is intended, perspective should present itself as an almost indispensable accomplishment, but one which it is also far more important to acquire through practice than theory. It is a rule that in perspective drawing, there are many ways of arriving at the desired result; and as a matter of fact, except in a few universal points, most draughtsmen have their own methods of reaching a given result. We never yet met a student who used the method given in Chapter xii. for making a sketch, but possibly it might be of service to a beginner. As specimens of drawings—a rather important, though neglected point—the illustrations leave something to be desired, and when architecture is given the design is also not the best selected. This, unfortunately however, is universal in many text-books. In Chapter xvi. the defects of perspective in photography are explained, and a useful method of correction is given, constituting a good feature of the work.

A diagram is also given of how to set a centrolinead, showing the increasing value attached to this useful instrument, which every student should be taught to handle.

The book is clearly arranged and well referenced, which is an important point for actual use, because whatever method of perspective setting-up the student uses, it is indispensable that he shou'd have it at his fingers' ends, so that he may not be hampered in devoting himself to an artistic result in his drawing; but, inasmuch as the memory is apt to be treacherous in such matters, facility of reference is an invaluable saving of time.

The volume on carpentry and joinery has also been written with the special object of preparing for examinations, and the present work refers to the first or preliminary course of the City and Guilds Institute, which is dealt with from a practical point of view; but a better title would be "mensuration, physics, plane and solid geometry, &c., as applied to carpentry, &c.," the bulk of the volume being taken up with these subjects. The book forms a good introduction to the subject, which we welcome as a method and an inducement for the British craftsman to study his craft in a more scientific manner than has been the case in the past. One or two points might be revised. Fig. 53 shows a pointed arch in stone which is scientifically wrong, as the meeting of the two arches should be a straight joint in order that each section may move independently without causing a fracture. Problem No. 90 could be described accurately instead of approximately by the "trammel" method, as indeed is explained in Problem 91. It is, perhaps, advisable to adhere only to exact methods for the workman, as he is liable to get muddled between two methods.

The exercises placed at the end of each chapter are well arranged, and should teach the workman to think for himself—a most important point.

Some misprints are, perhaps, inevitable where so many figures and letters are introduced, as 39° for 30° on p. 169. The chapter on isometric projection will be found very useful for explaining joints, &c., but the lettering to the diagrams is not as distinct as it might be, and could be improved by the author if a future edition is required. The chapters on setting out of

doors and windows are well arranged, but the joints at the feet of principal rafter and tie-beam in Figs. 245, 246, 247 and 248, will not, it is hoped, be repeated in succeeding volumes. The chapters on the resolution of forces, mechanical contrivances, bending moments, &c., give a prominent place to the scientific part of the subject, a study which we can with confidence advise the craftsman to undertake. The chapter on the determination of stresses might be made somewhat clearer, having regard to the class of man for whom the book is intended, if the author would take the forces acting at any point always in the same order, and work round with the sun. Under "mechanical contrivances" no mention appears to be made of the screw, which is specially mentioned in the syllabus. We refer with regret to the fact that there is no index, which detracts materially from the value of a well-arranged book.

A GERMAN POPULAR ASTRONOMY.

Das Weltgebäude.—Eine gemeinverständliche Himmelskunde. Von Dr. M. Wilhelm Meyer. Mit 287 Abbildungen im Text, 10 Karten, und 31 Tafeln, im Farbendruck, Heliogravüre und Holzschnitt. (Leipzig und Wien: Bibliographisches Institut, 1898.)

IN a very handsome volume, well written, well printed, and well illustrated, Dr. Meyer has given us the main results of astronomical observation. We may congratulate both the author and his readers on the selection of the facts that has been made, and submitted to consideration. The arrangement of the material has evidently been the subject of much care and thought; but we cannot say that the final result commends itself entirely to our judgment. In a short preface, Dr. Meyer has intimated the general principles by which he has been guided in preparing his work. He has wished the reader to appreciate the grounds on which certain truths have been received, and not simply accept the assertions as an outcome of authoritative teaching. He admits that without mathematical symbols and analysis it may be difficult to offer direct proof in support of many statements; but by translating the results of mathematical deductions into the language of ordinary life, he thinks it possible to find an efficient substitute. It is not without a feeling of apprehension that one reads of threats of this kind. Efforts to reproduce mathematical results without the use of the necessary machinery generally prove wearisome to the mathematician, and unintelligible to the ordinary reader. But Dr. Meyer has not taken the matter too seriously, and even in his chapter on the Newtonian system avoids the perils of adhering too closely to his own principles.

The author has divided his book into two parts. The first is descriptive, and in this section his endeavour is to describe the whole universe as it may be seen with instruments particularly designed for special ends. The causes for these appearances, or the theories by which they may be explained, are reserved for the second part. Whether such an arrangement is satisfactory can only be decided by the student. To any one who approaches the book with a fair amount of astronomical knowledge, it appears cut in halves, without sufficient reason. As it is impossible within a limited space to describe each section separately, the author's method of treatment may be illustrated by referring to the description of the moon, given in the first section, immediately after describing, not at too great length, but adequately, the telescope and spectroscope and the processes of photography and photometry. We have first of all an account of the phases, for the detection of which no telescope is necessary, and for whose correct explanation but little ingenuity is required. The instrumental examination of the moon begins with the application of the spectroscope to the light, and the obvious deductions that follow its use are necessarily given. Having discussed the absence of an atmosphere, the effect of the sun's heat, &c., we get to the telescope and trace historically the cartography of the moon from Hevel to Schmidt. Finally, and also following chronological order, we reach the age of photography and the delineations of Weinek from the Lick negatives, many of which are reproduced. Particularly good and interesting are the comparisons instituted between portions of the lunar surface and certain districts on the earth, not by any means with the view of suggesting that the configurations have been produced by similar processes in each case, but as a convenient way of illustrating points of resemblance or emphasising points of difference. The Island of Corsica, the Colorado Cañon, the Yosemite Valley are all in turn discussed and made to illustrate some generic feature on the lunar surface. Altogether it is the best description of the moon we have read; and it is only when we come to remember what is omitted, that we have any sense of dissatisfaction. For instance, we find nothing about the distance of the moon, though the diameter is given. This is surely a departure from the rule to be purely descriptive, though the description gains immensely by it, since it enables comparisons to be drawn between similar features on the earth. Moreover, while the distance remains undetermined, the diameter must be taken on authority; and this is opposed to the fundamental canon of the preface. The geometry of eclipses has to be relegated to the second part, similarly with other phenomena depending upon the mass of the moon, such as the action of the tides or the effects of precession and nutation. The advantage of the arrangement does not seem evident, nor does it entirely fulfil the purpose for which it was designed, although each part is admirable in itself, but wanting in completeness and connection. The method pursued with the moon is continued throughout the solar system, though of course there is not always the same necessity to return to omitted portions. From the members of the solar system we pass to comets and meteors, and finally to the universe of the fixed stars. It goes without saying that these chapters are not only correct, but offer us the latest information drawn, as they are, from experts in their several branches of investigation. For the author, distrustful of his own knowledge, and remembering that the fact of to-day is liable to be displaced by the newer discovery of to-morrow, prudently placed his manuscript for correction in the hands of various authorities. Thus, Schiaparelli either describes or confirms the description of Mars, and Dr. Scheiner, of Potsdam, is responsible for the accuracy of the chapters on spectrum analysis. Dr. Ginzel, who has written so largely on ancient chronology, is willing to assist here in the discussion of eclipses, while Dr.

Seeliger, it is admitted, has by his suggestions and revision materially improved the chapter on gravity. If the section on telescopes had also been overlooked by a competent authority, perhaps Herschel's giant telescope would have been erected at Slough rather than at Bath; but wherever these eminent authorities have co-operated with the author, it is needless to say that we have an admirable result, correct in all important particulars.

As an example of the character of the second part of the work, entitled "Motion of the Celestial Bodies," we select the chapter on the figure of the earth. We make this selection the more readily because it affords an apt instance, not only of the successful treatment of a difficult subject, but illustrates the thoroughness attempted in German popular works. In English books of similar character the tendency is rather to adhere to subjects that lend themselves to pictorial illustrations of an interesting kind, or are capable of easy description, making no great demand upon the attention. Sir Robert Ball, it is true, has given us some charming chapters on the wanderings of the Pole, but writers who wield a less facile pen have generally left the subjects connected with geodetic measurements severely alone. In the Ipswich Lectures, Airy taught us how a base line was measured, and how triangulation was effected; but his example has not been generally followed. Newer methods and more sensational results have swallowed up the interest that once belonged to the science of exact measurement. But to Dr. Meyer the subject is not unwelcome. Adhering to his general plan of first showing the main principles underlying any process, without introducing needless niceties invented to provide against sources of error, he keeps the attention of the reader fixed on the main object of the investigation, without being lost in the intricacies of detail. In this way we see how latitude and longitude are determined, the gradual elimination of errors from the observations, and the regular approach to scientific accuracy. There is nothing wearisome in the account of triangulation, for it is brightened and relieved here and there by references to ancient history, to past expeditions, and the results of previous measurements. As might be anticipated, one does not find much reference to English work, that is not the object of the book; it is not the history of results, but the history of methods that is under consideration, and the countryman of Bessel can find all he wants in the writings of that astronomer and in the work of the "Europäischen Gradmessung." The deviations of the earth's figure from that of the surface of an ellipsoid of revolution, and the variation of gravity with the causes that contribute to it, are set out in great detail, showing that the author expects an audience of very considerable intelligence to follow him. This is a point that constitutes for us the real interest of the book, the evidence it affords of the existence of more general information than is usually to be met with in English readers. The author must have been aware of the eagerness of a large class to possess exact information, and has catered for it; but we cannot imagine that this book would enjoy a very large circulation in this country. Between the mathematical reader and the "man in the street" there is a great gulf fixed, which works of this character are calculated to bridge, but which at present find no great support from either description of reader. W. E. P.

OUR BOOK SHELF.

La Vie: Mode de Mouvement. Essai d'une Théorie Physique des Phénomènes Vitaux. Par E. Préaubert, Professeur an Lycée d'Angers, &c. Pp. 310. (Paris: Félix Alcan, 1897.)

WE can hardly suppose that M. Préaubert intends his remarkable speculation to be taken seriously. His contention is that life is essentially a mode of motion of the ether, and as such is closely allied with electricity and magnetism; finding, like these forces, its expression but not its origin in ponderable matter. It is, he maintains, in consequence of the failure to recognise the ether as the true seat of vital activity that all attempts to explain the phenomena of life on a purely chemical or physical basis have hitherto broken down. With the removal of "vitality" to the region of the ether, the material difficulties vanish; the connection between vitality and the other forces of the physical universe becomes declared, and biology resolves itself essentially into a mere question of mechanics. What then is the true distinction between life, on the one hand, and light, radiant heat and electricity on the other? The author answers that life is a series, not of vibrations, but of vortex-movements; his discovery, in fact, could hardly be better expressed than in the words of the puzzle-headed old Athenian in the "Clouds"—

Δῖνος βασιλεύει, τὸν Δί' ἐξεληλακώς.

It need, perhaps, scarcely be said that in support of his central position he has nothing to offer but a collection of assumptions and analogies, the former practically baseless, and the latter more or less loose. He seems, indeed, to forget in practice, though he recognises in words, the distinction between analogy and identity; and anything deserving the name of proof is conspicuously lacking. Space will not allow us to deal with his statements in detail; he commits himself to many that would be called in question by both physiologists and morphologists. We cannot, however, refrain from expressing our wonder that so many writers on evolution should virtually ignore the firm foundation laid by Darwin. So far as M. Préaubert's biological arguments are concerned, the theory of natural selection might almost as well be non-existent.

We doubted at the outset whether the author expected to be taken seriously. His closing passage contains what is in effect a *reductio ad absurdum* of his whole theory. F. A. D.

The Barometrical Determination of Heights. By F. J. B. Cordeiro, Surgeon U.S. Navy. Pp. 28. (London: E. and F. N. Spon, Ltd., 1898.)

IN the calculation of mountain heights by means of the mercurial barometer, accuracy depends on the efficiency of the formulæ employed. These formulæ are based necessarily on assumptions, as we do not know exactly the varying conditions of the air, and we therefore fail to take into account the exact data for the correct solution of the problem. As a rule, the formulæ are at most only approximations; but it is astonishing what good results may be obtained by paying strict attention to all details.

In this neatly bound little book we have an essay on this subject, which was originally entered in the Hodgkin Prize Competition under the auspices of the Smithsonian Institution, and was awarded honourable mention. The author has briefly brought up to date the problem of barometrical hypsometry discussed many years ago by Guyot. He points out where the old theories were lacking in accuracy, and furnishes a method which, besides being rigidly correct in theory, gives trustworthy results in practice. As an illustration of this, a series of observations is added. In the appendix the author describes a form of

air barometer, the advantages of which over a mercurial barometer are compactness and portability, greater sensitiveness, greater simplicity in the calculations, and, lastly, greater cheapness.

All those who are interested in the measurement of heights by barometric methods should read these twenty-eight pages.

Laboratory Directions in General Biology. By Harriet Randolph, Ph.D., Demonstrator in Biology and Reader in Botany, Bryn Mawr College. (New York: H. Holt and Co., 1897.)

This booklet of 152 pages small octavo is a guide to a 142 hours' elementary laboratory course. The Fern and Earthworm are first dealt with, and then a series of animal and vegetable forms, in ascending order determined by convenience, the whole culminating in a small modicum of comparative embryology. Directions for manipulation are throughout rendered in italics. Of the making of books there is no end, but a pity 'tis that of the making of books such as this should be a beginning! The whole is but a set of rough laboratory notes of the time-table order, such as are everywhere used under prevailing custom and often destroyed when done with. They are of the kind justified only by the necessity for local adaptation of class work; but of this there is here no evidence, and we consequently regard their publication in book-form as superfluous.

The Freezing-Point, Boiling-Point and Conductivity Methods. By Harry C. Jones. Pp. vii + 64. (Easton, Pa.: Chemical Publishing Co., 1897.)

This little laboratory handbook is designed not merely as a guide to the manipulation of the methods of which it treats, but also to give the student an insight into the physical principles underlying them. The theoretical part is, however, in many places so compressed that, it is to be feared, the average student will hardly be able to follow it without some previous knowledge of the subject derived from other sources. The practical part is, on the other hand, very well done. It includes descriptions of Beckmann's and the author's apparatus for the determination of freezing-points of solutions, of the Beckmann boiling-point apparatus, as well as of the later forms devised by Hite and by the author, and of the Kohlrausch apparatus for the determination of the conductivity of solutions in the form described by Ostwald. The details of manipulation, on which the author's extensive practical experience of these methods entitles him to speak with some authority, should secure a hearty welcome for this book wherever laboratory instruction in physical chemistry is given.

Philip's Artistic Fruit Studies. By R. H. Wright. *Philip's Artistic Animal Studies.* By H. A. K. Dixon. (London: George Philip and Son, 1898.)

In the lower standards of Elementary Schools the children are given various occupations, such as plaiting, crayon drawing, and macrami work, having for its object the training of the hand and eye. The collections of plant and animal studies now before us have been arranged for this purpose, and they will afford the young pupils for whom they are intended both pleasure and instruction. Each collection consists of a series of twelve original designs, simply coloured, and a series of twelve outline drawings for colouring with crayons or paints. From the fruit studies the children will learn a few details concerning common fruits; and the animal studies, containing coloured drawings of queen, male and neuter bees, the development of the frog, and similar subjects will be of value in interesting the pupils in natural history.

It would be an advantage to young pupils if the name of the object were in every case distinctly printed under both the outline and coloured drawings.

LETTER TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature, *No notice is taken of anonymous communications.*]

"The Story of Gloucester."

May I ask the courtesy of a few words in further consideration of this, not in reply to your contributor, but as a plea for a little consideration to a few thoughts entertained by thousands on the other side of this controversy?

Let all the advocates of vaccination reflect that there is in the small-pox a disorder that affects the skin. That this serious damage to the skin is the real reason of the danger of the disorder; and that this damage to the skin makes any classification by skin marks a very unscientific and a very imperfect manner of dividing the cases. It is more serious than that. It makes classification by skin marks of vaccination almost certain to be erroneous. No certainty of correctness can be had, except in the mildest of the cases. In all the confluent cases, classification of the small-pox cases by skin marks will be in error with certainty. Therefore, as there has always been a most positive refusal to refer to the register of vaccinations, we have not the slightest reason for accepting the classification of hospital small-pox as correct. We have however, no other classification. We therefore must, perforce, accept for argument that classification. But we always do it with reserve.

These remarks are those which occur to us always in looking at the modern (post-vaccination) unvaccinated fatalities. If you are making a set of fatalities, which are enormously heavier than ever were recorded before Jenner began his vaccinations, then you are entitled to ask if there is in the fatality, taken as a whole, any justification for these unvaccinated fatalities, such as are now shown.

		Per cent.
Thus, Von Swieten's fatalities 150 years ago were under	...	2
The accepted fatality in this country before vaccination was ...	...	16
The Royal Commissioners give Chester, 1774	...	16·8
,, ,, ,, Ware, 1722	...	11·7
,, ,, ,, Old Small-pox Hospital, 1746-63	...	25·3

This last is the very highest I have ever been able to find. And it is fully accounted for by the statement made in the report of the hospital in explanation of it, that "most of them were adults, often admitted after great irregularities, and some when their cure was despaired of." The hospital was small, and there was not a general admission of patients. Only free admission was allowed for those who were to have the inoculated small-pox. We have then to set against those fatalities, which are exhibited, for the most part, as showing how serious a loss of life was risked by the non-inoculated, the fatality of our own hospitals since the enforcement of vaccination. Thus—

		Per cent. died.
Metropolitan Hospital, 1870-72	... ...	18·6
Homerton Hospital, 1871-77	... ...	19·43
Metropolitan Hospitals, 1876	... ...	23
Same Hospitals for 1876-1880	... ...	17·3
Dublin, 1876-1880	... ...	21·7

In the recent years, as there has been a crowding of all the cases into hospitals, and a great deal of hospital extension—never known previously—we have a rather lower rate, as was to be expected; thus—

		Died per cent.
Fulham, 1879	... ...	16·2
Metropolitan Hospitals, 1884	.. ...	15·8
Fulham, however, for 1885 was	... ...	24·3
And for Gloucester we have, 1895-96	...	21·9

There is here nothing to boast of in the fatalities of our compulsory vaccination period. There is never so low a fatality as that recorded by Von Swieten, or by Isaac Massey at Christ's Hospital, where only one child in some hundreds died (1722), and there is no avoiding the conclusion, that I can see, that if on the whole there is no lessened fatality, there is some error in the division, which makes one set appear to be vastly better off than the other. I have tested that in this way in the Gloucester cases, by asking if there was a single class free from fatality?

The answer is, of course, that there is not one. Government exacts multiple marks of vaccination, but in Gloucester it is clear that there was a better case for the single than for the multiple marks. Government exacts re-vaccination in the services, but here there is a large number of re-vaccinated cases, and twice Von Swieten's fatality in them.

Then, again, it is clear that the eruption has, as of old, everything to do with the fatality, and nothing can be clearer in the Gloucester cases. Unless, therefore, you have taken the precaution of giving reference to the register of vaccinations, you are in the fix of having almost certainly got wrong with your classification. Is there any test of this? There most certainly is. For in the variety of the disease, in which there is not so much damage to the skin as discoloration of it, where the poison is damaging the whole system, and internally more than externally, we have still the vaccination marks, if they are noted. I gave before the Commissioners all these cases that I had been able to trace in a large number of reports. And here is the fatality of these "malignant" cases.

	Per cent. died.
Vaccinated malignant cases	83·5
Unvaccinated cases	90
The first line divides thus—	
Vaccinated, no evidence	82
Doubtfully vaccinated	81
Indifferent vaccination marks	84
Good vaccination marks	85

It is very clear, therefore, that there is not the slightest influence in vaccination, good, bad, or indifferent, to abate the fatality of these cases. In some of the hospitals the whole of the vaccinated in this class died, without any recoveries. But that way of returning the cases is only followed occasionally, so that there is no possibility of taking all the hospital experience. There is however, no reason to suppose that it would show any different results. All these cases, with the almost unvarying total fatality, show that there is high time for a reference of every possible case returned as unvaccinated to the vaccination officer for his verification, and for information as to whether there had been the payment for successful vaccination. Till that is done, we have the right to say that there is not the slightest gain accruing from vaccination in the cures of the small-pox, and that there is all reason for declaring the present classification by skin marks in this eruptive disease unscientific and erroneous. ALEX. WHEELER.

Darlington, April 17.

[In deference to the wishes of Mr. Wheeler we print the enclosed letter, after which our columns must be closed to the subject unless something very important is brought forward. Of course, as Mr. Wheeler says, he has completely departed from the original controversy; and it is necessary to call attention to the fact that no amount of statistical jugglery, or reference to assumed historical data, can be held sufficient to refute the unquestioned fact that in Gloucester the unvaccinated children were attacked with small-pox and died in overwhelming disproportion to the vaccinated. Epidemics, as we know, cannot be compared with one another as regards their severity, but the incidence of attack in the same epidemic may always be taken as being fairly comparable throughout.—ED. NATURE.]

RÖNTGEN RAYS AND ORDINARY LIGHT.

ACCORDING to the theory of the Röntgen rays suggested by Sir G. Stokes,[1] and recently developed by Prof J. J. Thomson,[2] their origin is to be sought in impacts of the charged atoms constituting the kathode-stream, whereby pulses of disturbance are generated in the ether. This theory has certainly much to recommend it; but I cannot see that it carries with it some of the consequences which have been deduced as to the distinction between Röntgen rays and ordinary luminous and non-luminous radiation. The conclusion of the authors above mentioned,[3] "that the Röntgen rays are not waves of very short wave-length, but impulses," surprises me. From the fact of their being highly condensed impulses, I should conclude on the contrary that they *are* waves of short wave-length. If short waves are inadmissible, longer waves are still more inadmissible. What then becomes of Fourier's theorem and its assertion that *any* disturbance may be analysed into regular waves?

Is it contended that previous to resolution (whether merely theoretical, or practically effected by the spectroscope) the vibrations of ordinary (*e.g.* white) light are regular, and thus distinguished from disturbances made up of impulses? This view was certainly supported in the past by high authorities, but it has been shown to be untenable by Gouy,[1] Schuster,[2] and the present writer.[3] A curve representative of white light, if it were drawn upon paper, would show no sequences of similar waves.

In the second of the papers referred to, I endeavoured to show in detail that white light might be supposed to have the very constitution now ascribed to the Röntgen radiation, except that of course the impulses would have to be less condensed. The peculiar behaviour of the Röntgen radiation with respect to diffraction and refraction would thus be attributable merely to the extreme shortness of the waves composing it. RAYLEIGH.

April 18.

1 *Manchester Memoirs*, vol. xli. No. 15, 1897.
2 *Phil. Mag.*, vol. xlv. p. 172, 1898.
3 See also Prof. S. P. Thompson's "Light Visible and Invisible" (London, 1897), p 273.

1 *Journal de Physique*, 1886, p. 354.
2 *Phil. Mag.*, vol. xxxvii. p. 509, 1894.
3 Enc. Brit., Art. "Wave Theory," 1888; *Phil. Mag.*, vol. xxvii. p. 461, 1889.

THE BAKERIAN LECTURE.[4]

THE purpose of the lecture was to show that certain metals and certain organic bodies can act on a photographic plate in such a manner that, on treating it exactly as if it had been acted on by light, a picture is developed. When carrying on some experiments with photographic plates, a piece of perforated zinc was found not to act as a screen and give a picture of the holes, but to give a picture of the metallic part; and further, it was found that a bright piece of zinc, when coated with copal varnish, with the object of stopping any emanation of vapour from it, became more, not less, active; these were the accidental observations which gave rise to the present investigation. With regard to the action of the organic bodies: their activity is greater than that of the metals, and the experiments with them are more easily carried out, hence it was advisable to investigate to a considerable extent their action before undertaking the more intricate and, probably, more important action of the metals.

Printing ink is one of the many substances which will, both when in contact and when at a distance, act on a photographic plate, and it was shown that remarkably clear pictures can be obtained of ordinary printing and of lithographic pictures. Printing ink varies in composition, and if the ordinary newspaper's, for instance, be used, the density of the pictures obtained will vary considerably. The varnish known as picture copal is also an active substance producing a dark picture. The active constituent of the printing ink was proved to be boiled oil, and in the varnish to be turpentine; and these bodies alone can be used in place of the more complicated substance above named. If then boiled or drying oil was active, it was natural to try linseed oil in its ordinary state, and this proved also to be active; different specimens, however, of so-called pure oil vary very considerably in the amount of their activity. Passing from linseed oil to other vegetable oils, they were found also to be active, but apparently none so active as the linseed oil. Then, with regard to turpentine, a body belonging to a very different class of organic substances, it was found that bodies analogous to it—all the terpines,

4 Delivered before the Royal Society, March 24, by Dr. W. J. Russell, V.P.R S.

for instance—were exceedingly active bodies; and it is interesting to note that with some of them an effect on the sensitive plate, analogous to what photographers term reversal or solarisation, is readily produced. With excessive action, a white in place of a black picture is obtained, but with modified action an ordinary dark picture is formed. All the fragrant essential oils are active bodies, and all contain as an ingredient one or more of the terpines. Now a characteristic property common to all the above-named bodies, and to others which produce similar effects on a photographic plate, is that they are reducing or oxygen absorbing bodies; consequently it is probable that it is to this property that they owe their power of acting on a photographic plate. Bodies such as alcohol, ether, esters, benzene, petroleum spirit, &c., exert no such action. Linseed oil is the most active of the vegetable oils, and has the greatest oxygen-absorbing power, olive oil the least, and it can produce little or no action on a photographic plate. An interesting test as to certain impurities in inactive bodies, for instance in alcohol and in ether, can be founded on these reactions. Ordinary commercial samples of these bodies, when placed in a dish with a photographic plate above them, yield a picture; but on carefully applying the ordinary processes for purifying these bodies, the pictures produced become fainter and fainter, and at last entirely disappear, so that not only the process of purification can be rendered visible step by step, but its completion be proved. One remarkably interesting character of these actions is, that they can take place through thin layers of certain solid substances; for instance, through gelatin, celluloid, collodion, gutta-percha tissue, gold-beater's skin, tracing-paper, &c., and naturally the action permeates paper and other strongly porous bodies. In so doing it gives on the sensitive plate a picture of the structure of the body. That the passing through a medium such as gelatin is not one of mere absorption on one side and evaporation on the other, is proved by the formation, after having passed through the medium, of a clear picture of the surface, say hardened copal varnish, from which the action arose; and even when more than a single layer of gelatin is interposed between the active body and the plate, still a clear picture is produced. On the other hand, bodies such as glass, mica, and selenite are perfectly opaque to the action, and gum arabic and paraffin in thin layers do not allow the action to pass through. Experiments were described in the lecture to show that it is a vapour given off by the active bodies which is the immediate cause of the action on the photographic plate, not a fluorescence emanating from the active body. A card, for instance, painted with drying oil or copal varnish, smaller than the photographic plate, and placed below a sensitive plate with the film upwards, produces an action round the edge of the plate, which creeps slowly and unevenly towards the centre. An arrangement was also described with a series of mica plates, overlapping one another so as to cut off all direct view of the active body from the sensitive plate, but so arranged as to allow a space between each layer, so that a vapour could work its way from the source of the action to the sensitive film. Such an arrangement enclosed in a box produced a definite picture.

It was naturally to be expected that an inactive substance, such, for instance, as a piece of Bristol board, could be made active by placing it in contact with hardened drying oil or copal varnish, or simply by placing it over linseed oil or turpentine; and the Bristol board, although no change in the surface is visible, will now produce a definite picture. High temperatures cannot, of course, be used with photographic plates. Many experiments have, however, been made at 55° C., and the action at this temperature as compared to that at ordinary temperatures show that a very great increase of activity takes place with the increase of temperature.

Experiments similar to those which have been indicated as having been made with organic bodies, have also been made with the different active metals, and similar results obtained. Zinc is, perhaps, the most convenient metal to experiment with. That it possesses this property of acting on a photographic plate was first published by M. Colson, but unknown to the lecturer until after his first set of experiments were made. The following is a list of the metals which have been found to be most active, and they are arranged approximately in the order of their activity. Magnesium, cadmium, zinc, nickel, aluminium, lead, bismuth; then follows cobalt, tin, antimony, which are decidedly less active than the foregoing ones; and there are others which with very long exposure show some amount of activity. Again certain alloys, such as pewter and fusible metal, are active bodies, whereas ordinary brass and german silver are not so. Increase the amount of zinc in brass, and it becomes an active alloy. The conditions under which this change occurs are being investigated. From the first experiments which were made it was concluded that mercury was an exceedingly active metal, but it has since been proved that it is entirely inactive, and that the action previously obtained was due to the metal being alloyed with a trace of zinc. That an exceedingly small amount of zinc is capable of effecting this change in mercury, is an interesting and important fact. This action can also be utilised as a test for the absence both of zinc and lead (for this metal acts in the same way as zinc) in a specimen of mercury, and pictures were shown which exhibited the effect of several of the ordinary purifying processes on impure mercury.

In order to show that the action exerted by the metals is due to a vapour, as before stated, experiments similar to those made with the organic bodies, and other ones described in the lecture, have been carried out. For a metal surface to be active it must be bright; a piece of dull zinc, for instance, exerts no action on the photographic plate, but rub it with coarse sand or emery paper, and you get a surface which will give an exact picture of every line that is visible on the plate, and even when a sheet of gelatin or celluloid is interposed, still a picture of the metal surface is formed. As a further confirmation of the view that a vapour is given off by the metal, it was shown that a slow current of air passed over bright zinc and allowed to impinge on a photographic plate, acted on it and produced a picture. Interesting pictures of opaque bodies are readily produced by placing a plate of polished zinc behind them, and in this way, for instance, the structure of different papers and the water-marks they bear, the form of skeleton-leaves, &c., are obtained as pictures. The opacity which certain solutions give to paper, and the transparency which others communicate to it, is of much interest, and further experiments are being made on this branch of the subject.

Another curious action was mentioned, which is that zinc and other metals have the power of making certain inactive liquids active. If, for instance, alcohol or ether or acetic ether be digested for four days with bright zinc, it will become active and capable of producing a picture; filtration and even distillation does not restore the inactivity of the solution.

It appears then that many substances, both organic and metallic, are able to act on a sensitive photographic plate, and that exceedingly small quantities of these active bodies are sufficient to produce the effect. A piece of board laid on a sensitive plate will give a good picture of its structure, and even thin dry board 30 to 100 years old can be made to give its likeness. Dry cinnamon and many other bodies act in the same way. Other experiments were described showing how an accumulation of the active vapour from zinc could be demonstrated, and, further, how the vapour was reflected from the sides of a glass or paraffin tube, but absorbed by a paper one. The

foregoing outline shows some of the principal points described in the lecture. The subject is a far extending one, and it is more important at the present time to obtain accurate data than to suggest theories; many other interesting points have, in fact, already been determined. The lecturer noted that the above experiments had been made in the Davy-Faraday Laboratory.

ANDRÉE'S BALLOON EXPEDITION.[1]

ALTHOUGH the fact is not stated, this is a translation, and a singularly literal one, of the French original. It is to be regretted that obvious printer's errors or slips of the pen were not corrected; for example, "1892" for "1882" on p. 14, "south" for "north" on p. 280, and the somewhat serious misstatement of Andrée's last message on p. 10, which is the least excusable, as a facsimile with correct translation attached is given on p. 306. On p. 168 the translator computes 5000 cubic metres at 17,658 cubic feet instead of 176,580. A somewhat infelicitous if not unintelligible paraphrase of marking a pigeon's feathers with an india-rubber stamp, is fixing on labels by the aid of india-rubber wafers (p. 233). It must be stated, on the other hand, that the English edition is much better printed than the French, especially as regards the extremely interesting plates, and that it contains an effective coloured frontispiece showing the departure of the balloon.

The narrative is in two parts. The first, by M. Lachambre, describes the balloon and the process of its manufacture, the transport of the material to Dane's Island in 1896, the erection of a shed, the inflation of the balloon, the long waiting for a favourable wind, the deflation and return. The second part, by M. Machuron, the nephew and partner of M. Lachambre, describes the transport of the enlarged balloon to Dane's Island in 1897, the repair of the shed, re-inflation, and the casting off on July 11. Both authors describe their own work clearly and well. They have nothing to say as to Andrée's plans, his theory of circumpolar prevailing winds, or his probable fate. But the technicalities of balloon construction, and the dexterous manipulations of the delicate fabric as it was prepared far from workshops or extraneous help, are lightened by the ingenuous impressions of the two intelligent Parisians suddenly transported into so strange a world.

The balloon *Ornen* was constructed as a sphere sixty-six feet in diameter with a conical appendage. It was furnished with two lateral valves for releasing the imprisoned gas at will, a large automatic valve to let the gas escape whenever the internal pressure exceeded a certain limit, and a rending flap intended to be used to prevent bumping on finally alighting, and so constructed that a rope attached to a small grapnel, on being thrown to the ground, would tear a great rent in the side of the balloon, deflating it instantaneously. The cubic contents were 160,000 cubic feet; but this was increased for the second attempt to 176,000 cubic feet. The material used was pongee silk of double, triple, or quadruple thickness, according to the part of the balloon and the strain to which it would be subjected. The silk was prepared in pieces of about 18 inches in width, and the balloon was made up of horizontal zones, the joints of each successive zone being alternate, as in brickwork. When completed the whole was thoroughly and repeatedly varnished inside and outside. While both Andrée and the manufacturers were confident of the gas-retaining power of such a construction, we understand that some experienced aeronauts view it with great suspicion, and greatly prefer the old system of vertical gores. The wicker car was fitted up with marvellous ingenuity, and attached by a ring to a cord net thrown over the balloon. A cap of varnished silk on the top of the

FIG. 1.—The top of the balloon, showing the joinings of the pieces.

[1] "Andrée and his Balloon." By Henri Lachambre and Alexis Machuron. With coloured frontispiece and 44 full-page illustrations from photographs. Pp. 306. (Westminster: Archibald Constable and Co., 1898.)

balloon protected the net from snow. Andrée's plan was to keep the balloon within a few hundred feet of the ground by the use of heavy guide-ropes dragging over the ice or through the sea, a device which serves as an automatic regulator of height.

The erection of the balloon-shed, gas-generators, and the inflation of the balloon in the far north of Spitsbergen formed a very neat piece of engineering, of which the Paris firm and their Swedish colleagues may well be proud. We may recall the facts of the departure. The balloon glided through the demolished north side of its shed at 2.30 p.m. on Sunday, July 11, 1897, and slowly swept northwards across the bay and over the low hills on the horizon. The last authentic pigeon-message received runs: "July 13. 12.30 p.m. 82° 2′ N. lat., 15° 5′ E. long. Good journey E. 10° S. All well on board. This is the third pigeon-post.—ANDRÉE."

Beyond this all is conjecture; but before adopting pessimistic views as to the fate of Andrée, Strindberg and Fraenkel, we should remember how few believed in July 1896 that the *Fram* would ever return. There is still hope for the crew of the *Ornen*.

HUGH ROBERT MILL.

FIG. 2.—The balloon on its departure, showing guide-ropes.

THE BENEKE PRIZES.

THE Philosophical Faculty of the Georg-Augusts-University of Göttingen has just published the following information concerning the Beneke prizes for the years 1897 and 1901. On March 11, 1898, the birthday of Carl Gustav Beneke the founder of this prize, it was announced that no communication had been sent in for the prize competition for the year 1897. At the same time the Philosophical Faculty set the following problem for the year 1901.

The principle of continuity, or more exactly the representation by functions which can be indefinitely differentiated, has for a long time been regarded as a general valid foundation for the mathematical treatment of natural phenomena. Such a groundwork as this was quite naturally introduced by the discoverers of the differential and integral calculus. More recently, however, the progress of mathematical investigation has shown generally that this is founded on a great number of implicit suppositions to which we, in consequence of the inaccuracies of our sensitive perceptions, are not bound. Further, the assumption of the molecular constitution of matter is from the first in contradiction with well-known laws.

The Faculty wishes to receive a work of real scientific interest in which such questions will be treated in a general intelligent way, and in which a minute examination will be made regarding the admissibilty in relation to the appropriateness of the usual mode of representation. Communications may be mathematically or philosophically and psychologically inclined, and historical studies are desired but not demanded.

Papers competing for this prize must be written in a modern language, and will be received by the Dekan of the Philosophical Faculty up to August 31, 1900. A motto should be written on the title-page of the work and on the outside of a sealed letter which must accompany it, containing the name, profession, and address of the sender. In no other way can the name of the author be communicated. It is further requested that the address of the sender should be also written on the title-page, in case the prize should not be awarded to it. The first prize amounts to 3400 marks, and the second to 680 marks.

The prizes will be awarded on March 11, 1901, at a meeting of the Philosophical Faculty in Göttingen. The communications to which prizes are awarded remain the property of the authors. The prize problems, for which the competitive papers must be sent in by August 31, 1898, and August 31, 1899, will be found given in the *Königlichen Gesellschaft der Wissenschaften Geschäftl. Mittheilungen*, 1896, S. 69, 1897, Heft. 1, S. 26.

NOTES.

THE Committee of Administration of the Paris International Exhibition of 1900 have adopted a scheme of arrangement of the exhibits according to the nature of the objects, instead of by nationalities. The exhibits will be arranged in groups, containing between them 120 classes. The subjects of the groups are: education and teaching, literature, science and art, instruments and processes; machinery and mechanical processes; civil engineering, construction, means of transport; agriculture, horticulture, arboriculture, forestry, sport, &c.; alimentary products; mines and metallurgy; decoration and furniture of public and private buildings; yarns, fabrics, clothing; industrial chemistry; miscellaneous industries; social economy, hygiene, public charities; colonisation; naval and military.

PRINCE ALBERT OF MONACO gave an account of his investigations in the Atlantic at the meeting of the Royal Geographical Society on Monday. From 1885 to 1889 Prince Albert made some long cruises in the *Hirondelle*, a little sailing schooner of 200 tons, which took him as far as the American coasts, and he explored depths as great as 1600 fathoms without help of any power greater than the arms of his fourteen sailors. The *Hirondelle* being shattered by storms, he built a stronger steam-vessel, the *Princess Alice*, 560 tons, to carry on the same research with better appliances. The work of this second period opened up to him fields of labour altogether beyond his reach without the aid of a still larger and more powerful vessel, so he commissioned Messrs. Laird, of Liverpool, to build him another *Princess Alice*, which is expected to set out on her first voyage in a few weeks. After giving the results of the more important of his observations with respect to currents, depth and pressure, temperature, salinity, light, and ocean deposits, Prince Albert proceeded to treat of the organic life inhabiting the waters of the open ocean, and described the principal apparatus employed by him for biological investigations.

MR. W. H. PREECE, C.B., F.R.S., was elected president of the Institution of Civil Engineers at the annual general meeting held on Tuesday.

MR. J. J. H. TEALL, F.R.S., has been elected into the Athenæum Club, under the rule which empowers the annual election of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

THE Royal Photographic Society's International Exhibition was opened by the Prince of Wales at the Crystal Palace on Monday. A large number of interesting photographs, many of them illustrating scientific applications of photography, are included among the exhibits.

THE annual reception and exhibit of recent progress in science of the New York Academy of Sciences was held on April 13 and 14. Though not so large as former exhibitions, it was characterised by the president of the Academy, Prof. Henry F. Osborn, as the most complete and diversified of any, representing nearly all the leading educational institutions of the United States, and containing exhibits from very many of the States and many foreign countries. Addresses were delivered by the recording secretary, Prof. Richard E. Dodge, President Osborn, Prof. George E. Hale, of the Yerkes Observatory, on "The Function of Large Telescopes," Mr. Morris K. Jesup, president of the Museum, and Mr. Charles E. Tripler, who exhibited liquid air obtained by his apparatus. Among the objects included in the exhibition, the fine array of photographs of stars and star spectra was noticeable. In the department of photography some excellent colour photographs were shown, including a demonstration of colour photographs by the Joly process, shown by the Joly-Zambra Company.—In electricity, apparatus was exhibited for the transmission of signals without intervening wires. The feature of the palæontological exhibition was the caudal vertebræ and limb bones of the gigantic Dinosaur Camarasaurus, the largest land animal that ever lived. The bones exhibited were the largest yet found, and were recently exhumed. Several new kinds of apparatus were shown in the physics section. Specially important, in an economic sense, was the stremmatograph, an instrument to measure compression and extension of rails of a railroad during the passing of trains, exhibited by Mr. P. H. Dudley.—The geological exhibit contained many interesting features; including specimens brought back from the excursion of geologists after the geological congress in Russia last year, some of the latest maps of the U.S. Geological Survey, a model of the Franklin furnace zinc ore bed from New Jersey, gold-bearing conglomerates from the so-called "banket" reefs near Johannesburg, South Africa. Specimens of compressed marble were shown, which had been subjected to the pressure of 100 tons to the square inch without rupture or destruction of cohesion.—Mr. H. E. Crampton, jun., exhibited some fine specimens of fused or compound pupæ and compound adult moths. His recent products include some very perfect tandem moths with two full sets of wings; also moths which have the head of one grafted upon the back of another. The exhibition of ethnology included results of the Jesup North Pacific exploring expedition and collections of the Huichol Indians of Mexico. The exhibits generally were designed to show the progress made during the year. The department of philology, however, having only been added to the exhibition this year, took a wider range.

IT is announced in *Science* that at the recent annual meeting of the New York Academy of Sciences the following elections as Honorary and Corresponding Members were made: *Honorary*—Prof. Arthur Auwers, Astronomer, Berlin; Prof. W. K. Brooks, Biologist, Baltimore; Prof. David Gill, Astronomer, Cape Town; Dr. George W. Hill, Mathematician, Nyack; Prof. E. Ray Lankester, Zoologist, Oxford; Dr. Fridjof Nansen, Explorer, Kristiania; Prof. Albrecht Penck, Geographer, Vienna; Prof. Wilhelm Pfeffer, Botanist, Leipzic; Prof. Hans Reusch, Geologist, Kristiania; Prof. Rudolph Virchow, Biologist, Berlin; Prof. Karl von Zittel, Palæontologist, Munich. *Corresponding*—Prof. F. D. Adams, Geologist, Montreal; Prof. I. B. Balfour, Botanist, Edinburgh; Prof. George Baur, Palæontologist, Chicago; Prof. William Carruthers, Botanist, London; Prof. T. C. Chamberlin, Geologist, Chicago; Prof. Wm. M. Davis, Geographer, Cambridge; Prof. Adrien Franchet, Botanist, Paris; Prof. George E. Hale, Astronomer, Chicago; Prof. J. P. Iddings, Geologist, Chicago; Prof. Charles S. Minot, Biologist, Boston; Prof. George Murray, Botanist, London; Prof. William B. Scott, Geologist, Princeton; Mr. Charles D. Walcott, Geologist, Washington; Prof. Charles O. Whitman, Biologist, Chicago; Prof. Henry S. Williams, Palæontologist, New Haven.

A VERY elaborate series of experiments on the tractive resistance of express passenger trains running on the Northern of France Railway shows (says *Engineering*) that the engine and tender resistances amount to about half the total. The trains on which the experiments were made weighed, on the average, 160 tons, exclusive of the engine and tender, which weighed 85 tons more.

THE Royal Agricultural Society offers, in connection with the meeting at Maidstone next year, a prize of 50*l*. for the best machinery for washing hops with liquid insecticides, the machine in question being worked by horse or mechanical power. Full particulars of the regulations governing the proposed competitive trials can be obtained on application to the Secretary, 13 Hanover Square, London, W.

Prof. James E. Keeler, of the Allegheny Observatory, has definitely accepted the post of director of the Lick Observatory, and will go to Mount Hamilton next month. It will be remembered that he offered to remain at the Allegheny Observatory if 200,000 dollars could be collected to erect and endow a new observatory. The subscriptions did not reach this amount in the two weeks allowed, but 150,000 dollars was subscribed, so that a new observatory will be built.

A new coherer for use in connection with telegraphy without intervening wires has been invented by Dr. H. Rupp, of Stuttgart. Instead of using an electro-magnetic tapper to tap the coherer tube, and so loosen the iron filings in it, Dr. Rupp has devised a simple contrivance for making the coherer rotate round the axis of the leading-in wires. It is stated that the Morse signals obtained with this rotating coherer are much more distinct than those given by the tapping arrangement.

Dr. Henry Marshall, a distinguished member of the medical profession, died on Sunday at Clifton, Bristol. Dr. Marshall received his medical education at Edinburgh; and in 1854, was dresser and afterwards assistant under Lord Lister, whom he succeeded as house surgeon. Whilst in Edinburgh he held the presidency of the Royal Medical Society there. When the British Medical Association met at Bristol in 1863 Dr. Marshall acted as secretary, and he was president of the Bristol branch when in 1877 the Association met at Bath.

We have just received, with regret, the announcement of the death, on March 24, of Mr. Alfred U. Allen, of Bath, at the age of sixty-four. Mr. Allen's name will be long remembered by microscopists as the secretary of the Postal Microscopical Society, which came into existence about twenty-five years ago largely through his exertions. It is only a few months since we announced that Mr. Allen had found it necessary to discontinue the *Journal of Microscopy and Natural Science*, which he edited since 1882. In addition to this, Mr. Allen issued a monthly journal, under the title of *The Scientific Enquirer*, during the years 1886–88.

Col. Sir Vivian D. Majendie, K.C.B., the chief inspector of explosives to the Home Office, died suddenly on Sunday. He was the author of the Official Guide-book to the Explosives Act of 1875, and several other professional works. In his official capacity he was responsible not only for the periodical inspection of the various gunpowder and kindred manufactories scattered throughout the country, and for the investigation of the circumstances attending the accidents that occur in them from time to time, but also had to examine very many of the bombs and infernal machines that fell into the hands of the police, or were left for felonious purposes in public places. He was also concerned with drawing up regulations for the storage of inflammable liquids such as petroleum, and it is not very long since he returned from a tour in America undertaken to study the methods of storage and transport in operation there.

Zoology has lost an able student and a promising investigator by the death, at the age of twenty-six years, of Mr. B. B. Griffin, announced in *Science*. Mr. Griffin took part in the zoological expeditions to the north-west coast of America, sent out by Columbia University in 1896 and 1897. He was the author, wholly or in part, of several papers relating to the fauna of that region, one of which, dealing with the nemertines of Puget Sound and describing a number of species new to science, had been sent to press immediately before his last illness. His principal work lay, however, in the field of cellular biology, and a brief but important paper by him on the fertilisation of the egg in *Thalassema*, published in the *Transactions* of the New York Academy of Sciences for 1895–6, had attracted considerable attention, both in the United States and elsewhere. A more extended paper along the same lines, bringing forward new and important evidence on the nature of fertilisation, the history of the centrosome, the phenomena of chromatin-reduction and other vexed problems of cytology, was practically ready for the printer at the time of his death.

We regret to record the death of the distinguished geologist M. Jules Marcou. He was born at Salins in the Department of Jura in France, in 1824. In 1848 he joined Agassiz at Boston, in the United States, and spent two years in studying the geology of various portions of North America. In 1853 he published a Geological Map of the United States, and the British Provinces of North America. For a period of about twelve years M. Marcou appears to have spent much of his time alternately in Europe and America. In 1855 he became professor of geology and palæontology at the Polytechnic School of Zürich, but relinquished this office on his return to the United States in 1860. In 1861 he published his well-known Geological Map of the World, of which a second edition was issued in 1875. In addition to his works on the geology of North America, he published many papers on the European secondary rocks, and was specially interested in the Jura-Cretaceous formations. Some of his articles were of a controversial nature. In 1879 he was elected a Foreign Member of the Geological Society of London. He died on April 18, at Cambridge, Massachusetts, aged seventy-four.

It is with much regret that we record the death of Dr. John Shearson Hyland, F.G.S., at the early age of thirty-two. The second son of Captain P. Hyland, of Great Crosby, he was educated at the Merchant Taylors' School, at University College, Liverpool, and subsequently at Leipzig. At the University of Leipzig he studied mineralogy and petrology under Dr. Zirkel, and took the degree of Ph.D., his thesis being entitled "Ueber die Gesteine des Kilimandscharo und dessen Umgebung," and published in 1888. In the same year he joined the staff of the Geological Survey, and was for three years occupied in the Irish branch in investigations on the eruptive rocks of the country. During this period he published several papers on petrological subjects, and gave great promise of a brilliant career. Being of an active, enterprising nature, he relinquished the work of the microscope, and throwing up his post on the Geological Survey, took to the more practical work of reporting on mineral resources in the United States, subsequently in British Central Africa, and finally on the treacherous west coast of Africa, where he died at Elmina on April 19.

The death is announced of Dr. J. G. N. Dragendorff, for many years director of the Pharmaceutical Institute at Dorpat, in Russia, which, while he was there, had the highest reputation as a pharmaceutical training college and school of research. From the *Chemist and Druggist* we learn that Dr. Dragendorff was born in Rostock in 1836. After qualifying as an apotheker, he studied chemistry in the Heidelberg University, which he left in 1860 to become assistant to Prof. F. Schultze, in the chemical laboratories of the Rostock University. In the same year he graduated as Ph.D., his thesis being on the action of phosphorus upon some carbonates and borates. In 1862 he went to St. Petersburg to take charge of the *Pharmaceutischen Zeitschrift für Russland*, as editor, and of the laboratories of the Pharmaceutical Society there. While acting in that capacity his reputation grew, and his appointment as Professor of Pharmacy and Director of the Pharmaceutical Institute at Dorpat in 1864 was the beginning of thirty years' work which made the Dorpat Institute famous all over the world, for Dragendorff's skill as a teacher and discoverer of talent brought students to him from all quarters. He retired to his native town in 1894, and devoted his leisure to a monumental work on medicinal plants, of which at least one part has been

published. He was best known to English pharmacists through his "Plant Analysis," a translation of which, by his former pupil, Henry G. Greenish, was published in 1883. His work on alkaloids was, however, that by which he is most entitled to fame. The mydriatic alkaloids were his special field, and his syntheses of conine and atropine are amongst the most brilliant achievements of modern chemistry. In 1885 the Pharmaceutical Society of Great Britain conferred the third Hanbury medal upon him.

THE Kew Observatory Committee have issued their Report for the year 1897. During that period the magnetic curves have been free from any very large fluctuations; the mean westerly Declination for the year was 17° 6′, and the mean Inclination, 67° 20′. The meteorological observations conducted for the Meteorological Council call for no special remarks; the electrograph has been in nearly constant operation since January 19. Several hours' record were lost owing to the trace being off the sheet; Dr. Chree states that it is difficult to see how such loss can be avoided without either duplicating part of the apparatus, or by risking possible loss of negative trace by shifting the position of the zero line on the sheet. Sketches of sun-spots were made on 165 days; it has been decided to discontinue the eye observations, owing to the elaborate photographic work now done elsewhere. Among the various experiments and researches in connection with the several departments we observe that attention has been given to the comparison of platinum and mercury thermometers at high temperatures, in view of repeated requests for direct high temperature verifications. Experiments are also being made as to the thermometric properties of different kinds of glass, the results of which will be eventually published. The usefulness of the institution is shown by the continual increase in the number of instruments submitted for verification; the increase during the year in question amounted to nearly three thousand. In addition a large number of watches and marine chronometers were received for trial.

A NUMBER of investigations have been made on the connection of various terrestrial phenomena with the period of rotation of the sun, but the results obtained have not been definite enough to establish the reality of a twenty-six-day period of meteorological phenomena. In connection with this question, Prof. Arthur Schuster subjects the methods of finding hidden periodicities—small periodic variations hidden behind irregular fluctuations—to vigorous analysis in *Terrestrial Magnetism* (March), with the object of introducing a little more scientific precision into the treatment of problems involving hidden periodicities, and of applying the theory of probability in such a way as to assign a definite number for the probability that the effects found by means of the usual methods are real, and not due to accidental circumstances. The methods described show the lines which investigations on the periodicity of phenomena should follow, and point to several interesting subjects to which they may profitably be applied. As to results already published, Prof. Schuster concludes:—"The general result of a critical examination of the published investigations on the twenty-six-day period leads me to think that, although the magnetic elements and the occurrence of thunderstorms seem to be affected by a period of twenty-six days and of its first multiple, the subject requires a good deal of further study before we can be sure as to the exact nature of the period. Even though it may be considered as proved, it must not be necessarily assumed that it is due to solar action. If it was a question merely of magnetic disturbances, there does not seem to be any great improbability, however, that some periodicity may be connected with the sun's rotation about its axis, especially at times of great sun-spot activity."

IN a short note in the *Comptes rendus* (No. 15, April 1898), M. Thiébaut gives us the result of his investigations on the frequency of the extra large tides which occur at the March equinox. He has used the number previously published in the *Connaissance de Temps* since the beginning of the century, and has shown that the relative magnitude of the coefficients of the tides at the syzygies vary notably from one year to another, but that the rule given below is subject to some exceptions. From the theoretical point of view this law of the variation of the coefficients assigns to the return of this great tide a period of about nine years if only one equinox is considered, or four and a half years if one indifferently takes account of the spring or autumn equinoxes. The principal cause of these variations he attributes to the movement of the moon's perigee, which completes one revolution in about 8 years and 310 days. Taking into account all the circumstances of the phenomenon he discovered a remarkable period of 412 days, at the completion of which the sun returns to the lunar perigee. This period he calls the "année périgéenne"; and it does not differ very much from two other interesting periods, one of 413·4 days, which corresponds to 14 lunar months (synodic), the other of 413·3 days, or 15 anomalistic months.

THE theory which attributes volcanic eruptions to disturbances produced beneath the earth's crust by luni-solar tide-generating forces would receive striking confirmation by the establishment of a connection between the periods of greatest volcanic activity and the phases of the moon which give rise to spring tides. Prof. Eugenio Semmola, writing in the *Atti del R. Istituto d'Incoraggiamento* (Naples), has compared the periods of maximum and minimum activity of Vesuvius with the phases of the moon during the two years from July 1895 to July 1897. The conclusions drawn from these observations are entirely of a negative character; the number of days of maximum and minimum activity being largely in excess of the number of lunations in the same period, and the fresh flows of lava being distributed fairly evenly between the moon's four quarters. A comparison of the more violent eruptions of Vesuvius from the year 1800 to the present time shows that in five of these the nearest phase of the moon was the new or full moon, and in the remaining five the nearest phase was the first or last quarter. It thus appears that no relation exists between the activity of Vesuvius and the phases of the moon.

THE *Journal de Physique* for April contains the continuation of an important paper, by M. A. Leduc, on the densities and molecular volumes of gases. M. Leduc has established, under the name of "law of molecular volumes," a limiting law, which he proposes as a substitute for the principle of Avogadro and Ampère. This law he applies to the calculation of the densities and coefficients of expansion of a number of gases, and every experimental determination appears to agree with the predicted results.

IN the same journal, M. J. Macé de Lépinay gives a proof that the fringes of caustics and the supernumerary arcs of rainbows can be regarded as true interference-fringes.—M. P. Morin considers the influence of the length of magnets on their mean intensity of magnetisation. In needles of the same material and cross-section magnetised to the point of saturation, the intensity of magnetisation and the magnetic density at the two ends are independent of the length of the needle, and the same is the case for all sections taken at equal distances from the extremities.

NEW magazines devoted to discussion of the Röntgen rays appear to be springing up in every direction. From St. Louis we have received the *American X-Ray Journal*, which is stated on the cover to be "a monthly devoted to the practical application

of the new science and to the physical improvement of man." It is illustrated by very fair radiographs of fractures and dislocations, and a somewhat striking "skiagram" of a loaded Lebel rifle.

We have received the second part of the *Annales d'Électrobiologie, d'Électrothérapie et d'Électrodiagnostic*. This new bimonthly journal deals with the applications of electricity to medical purposes, including the uses of Röntgen rays. In addition to original papers, a full bibliography of current literature is given. M. Félix Alcan, of Paris, is the publisher.

Writing in the *Rendiconti del R. Istituto Lombardo*, xxxi., Signor Luigi de Marchi criticises the views advanced by Arrhenius on the causes of the variations of climate considered specially with reference to the influence of carbonic acid on the temperature of the ground (see *Philosophical Magazine*, 1896, p. 237). He considers that Arrhenius is in error (1) in treating as negligible the variations in the solar radiation produced by even considerable increases in the carbonic acid and watery vapour of the atmosphere; (2) in attributing a definite physical meaning to the coefficient which represents the coefficient of emission of a fictitious stratum whose radiation is equivalent to that of the atmosphere; and (3) in assuming that the same coefficient also represents the coefficient of absorption of the stratum in question for terrestrial radiations.

The Astronomical and Physical Society of Toronto seems to be in an ever flourishing condition, judging from the *Transactions* which appear from time to time. The latest volume, for the year 1897, which includes the eighth annual report, displays the Society's activity by the numerous and varied papers which were communicated during the past twelve months. Among these papers may be mentioned an historical sketch of the Greenwich *Nautical Almanac*, periodicity of magnetic elements, the November meteors of 1832 and 1833, the variable star Algol, &c. Mr. G. E. Lumsden made a short communication on the best method of making the work of the Society valuable, and his suggestions are such that any other society might learn a good lesson by following them. We hope to see this scheme carried out successfully, as its lines, corresponding to those of the subdivision of labour of the British Astronomical Association on this side of the Atlantic, are undoubtedly sound.

Several interesting reminiscences of the Edinburgh Medical School in the 'fifties and 'sixties are given in an article in *Chambers's Journal* for April. The teachers in the University at that time—Syme, Simpson, Goodsir, Christison, Hughes-Bennett, Playfair, Douglas Maclagan, Laycock, Turner, Allmann, Balfour, Henderson and the rest—all take prominent places in the history of the science and practice of medicine. Referring to Sir James Simpson and the use of chloroform, the writer remarks that deaths under this anæsthetic were almost unknown in his days. He says: "We hardly ever used a stethoscope to examine the heart, or felt the pulse, and the patients did not die. . . . Both Simpson and Syme taught that chloroform should be inhaled from being sprinkled on a towel, the two golden rules being to see that the vapour was properly diluted by the surrounding air, and to watch the breathing, holding the towel some inches from the face. It may be a coincidence merely; but if so it is remarkably strange that, while the chloroform has not changed, while the constitutions of the patients have not changed, where the use of an inhaler is the rule, there are frequent deaths from chloroform; whilst in Scotland and Ireland, where the use of an inhaler is the exception, deaths are proportionately rare."

Some interesting investigations on the behaviour of micro-organisms in the presence of compressed gases have been published by G. Malfitano in the *Bollettino della Società medico-chirurgica di Pavia*. The more importance attaches to these researches, inasmuch as compressed carbonic acid gas has been lately regarded by some authorities as endowed with trustworthy antiseptic or sterilising properties. Malfitano's investigations do not, however, support this view. A large number of experiments were made with pure cultures of various bacteria in a dry condition, exposed for periods of time varying from 20 to 64 hours to a maximum pressure of 55 atmospheres. Whilst some bacteria were destroyed, amongst which we note *B. coli communis*, *B. anthracis*, *saccharomyces cerevisiæ*, the hyphomycetes, and *B. subtilis*, invariably withstood this influence. In other experiments we find again a large number of bacterial varieties exposed to pressures varying from 60-25 atmospheres, with the result that whilst typhoid and cholera bacilli, the *B. prodigiosus*, staphylococcus pyogenes aureus, and citreus and other well-known varieties succumbed more or less rapidly, *B. subtilis*, *B. mesentericus*, Tyrothrix, and *B. œdematis* invariably survived. It should be mentioned that no permanent biological modification in the bacteria employed was observed to result from exposure to compressed carbonic acid gas. Judging by experiments carried out to ascertain the relative effect of length of exposure to, and degree of pressure of this gas upon bacteria, it would appear that the latter factor was of more importance than the former. Endeavours were made to, if possible, increase the bactericidal potency of the gas, by submitting bacteria to the *interrupted* action of the gas. For this purpose subtilis bacilli, containing their well-known hardy spore forms, were employed. These bacilli were exposed for 20 hours to the gas at intervals of 24 hours, this being repeated four times, but no different result followed. It will be remembered that alternately freezing and thawing bacteria tends to increase the sensitiveness of, at any rate, some bacteria to extreme cold. The author tried, finally, the effect of liquefied carbonic acid gas upon the vitality of the spores of *B. subtilis*; but from this test, also, they emerged triumphant, suffering no damage at all.

The current number of the *Journal of the Sanitary Institute* contains papers on a variety of subjects; amongst them we notice one on poisoning by canned foods, by Dr. F. Brown. The writer has collected all the reports which have appeared in medical journals since the year 1879 of cases of poisoning from tinned foods. As regards fish and meat thus preserved, the poisonous effect is probably due to the presence of ptomaïnes, and the only way of preventing this dangerous deterioration is to take all possible precautions that the materials used are of the very best quality, and that the canning process is carried on under the strictest hygienic conditions. Canned fruits do not appear to have been responsible for any fatal cases of poisoning, but salts of tin and zinc are frequently present in such materials. In some instances, especially in cans containing pears and apricots, lead in quantities sufficient to give rise to lead-poisoning was found, whilst in other canned fruits the apricots had acquired a metallic taste from the amount of metal present. As all canned foods are better for being used soon after canning, a good plan would be to state on each tin the date of its canning, so that the public may have some guide as to the quality of the article they are purchasing.—A paper on the contamination of water supplies by encampments of hop-pickers, gipsies, &c., is contributed by Miss Chreiman. Although some allowance must be made for the unfortunately exaggerated style of the writer, there can be no doubt that she has done good service in once more bringing before the general public the highly unsatisfactory conditions under which hop-picking is now carried on. Possibly the Maidstone typhoid epidemic of last autumn may succeed in rousing local authorities to take effective measures to provide for, and officially organise, this periodic invasion of country districts. Surely, for example, the sleeping

on "beds of short straw, beneath which was a mattress of cattle manure two spades deep," ought to be an impossibility at the close of the nineteenth century.

A PRELIMINARY report, by Mr. Milton Whitney, upon the soils of the principal tobacco districts in the United States has just been published by the United States Department of Agriculture. The tobacco-plant readily adapts itself to a great range of climatic conditions, and will grow on nearly all kinds of soil, but the flavour and quality of the leaf are greatly influenced by the conditions of the climate and soil. So far as climate is concerned, Mr. Whitney remarks that experience is the only safe test as to the class of tobacco which can be produced under given climatic conditions. Ordinary meteorological records appear to be of little value in determining this point; for the tobacco-plant is more sensitive to meteorological influences than the instruments. Even in such a famous tobacco region as Cuba, tobacco of good quality cannot be grown in the immediate vicinity of the ocean, or in certain parts of the island, even on what would otherwise be considered good tobacco lands. This has been the experience also in Sumatra and in the United States, but the influences are too subtle to be detected by ordinary meteorological instruments. Little, therefore, can be said at the present time in regard to the suitable climatic condition for tobacco of any particular type or quality. Under given climatic conditions, the class and type of tobacco depend upon the character of the soil, especially on the physical character of the soil, upon which it is grown. The texture or coarseness of the soil grains, and the water content, which is largely dependent upon it, appears to determine and control the distribution of the different widely distinct types of tobacco. This conclusion is borne out by Mr. Whitney's mechanical analyses of tobacco soils, consisting of separating the particles of soils into grades of different sizes. The results show a very marked difference in the texture and physical properties of the soils adapted to the different classes, types, and grades of tobacco, and give a basis for the classification of tobacco soils.

DR. SUPAN has a short article on antarctic exploration in *Petermann's Mittheilungen*. The German and English proposals are described, and Brückner's calculations of climatic periods quoted to show that the present is an exceptionally favourable time for penetrating southward. The period of Ross's voyages was probably much colder than the average.

DR. ERICH VON DRYGALSKI publishes in *Petermann's Mittheilungen* a paper on ice movements, their physical causes, and their geographical effects. The paper is in effect an abstract of results of the work of the Greenland expedition of the Berlin *Gesellschaft für Erdkünde*, published in full as a separate volume in the course of last year.

THE April issue of the *National Geographical Magazine* is a Klondike number, and contains several trustworthy articles on the conditions, resources and future of Alaska and the Yukon gold-fields. A map of the gold- and coal-fields of Alaska, and showing also the principal steamer routes and trails, on a scale of about fifty-seven miles to one inch, accompanies the papers in the magazine.

NOS. 5 and 6 of vol. xxxii. of the *Zeitschrift der Gesellschaft für Erdkünde zu Berlin* contain papers by Herr E. de Martonne on the hydrography of the basin of the Upper Nile, by Dr. A. Galle on Dr. Philippson's measurements of heights on the Greek islands of the Ægean, on a new map of the eastern part of New Britain by Freiherr von Schleinitz, and on journeys in the Upper Amazon region by Dr. A. Rimbach. Herr E. de Martonne's paper is a review of the present state of knowledge regarding the Upper Nile, with a new orographical map and a sketch of seasonal distribution of rainfall.

AMONG the papers in the current number (April) of the *Journal* of the Royal Horticultural Society are several of scientific interest, in addition to papers on progress in the methods and results of cultivation. Mr. C. C. Hurst describes some curiosities of orchid breeding, and his experiments and observations on hybrids are of distinct value. Prof. F. W. Oliver has a paper on the depth in the soil at which plants occur, and Prof. Geo. Henslow one on chrysanthemum sports.

AMONG reprints of important papers from the *Botanical Gazette* we have received:—Winter characters of certain sporangia, by Charles J. Chamberlain; contributions to the life-history of *Ranunculus*, by Prof. Coulter; and a general review of the principal results of Swedish research into grain-rust, by Prof. J. Eriksson. The Swedish professor distinguishes eight distinct forms of *Puccinia* which produce rust; these being again arranged under a number of secondary forms, dependent on the host-plant, most of the primary forms being parasitic on several different species.

THE views with regard to the origin of vertebrates, put forward by Dr. W. H. Gaskell, F.R.S., in his presidential address to the physiological section of the British Association, at the Liverpool meeting in 1896, are to be stated more fully in the *Journal of Anatomy and Physiology*. The April number of the *Journal* contains the first of a series of papers in which Dr. Gaskell will fill in the details of evidence which were necessarily omitted from his address.

A COPY of Mr. Joseph Baxendell's report on the results of observations made at the Southport Corporation Meteorological Observatory during 1897 has been received. A noteworthy feature of the report is a comparative table showing the mean annual meteorological statistics for every health resort in the United Kingdom known to possess a meteorological station. The systematic work done in the meteorological department of the borough of Southport should encourage accurate health resort climatology in general, and municipal meteorology in particular.

INCLUDED in the "Bergens Museums Aarbog" for 1897 is Prof. R. Collett's interesting paper on Beavers in Norway, with twelve plates reproduced from photographs of beaver lodges and dams. The subjects of other papers are:—Generalisation of some algebraic equations which present themselves in the theory of elliptic functions; a Sowerby Whale (*Mesoplodon bidens*, Sow.), stranded on the west side of Karmö Island; histological studies of the structure of the eyes of certain marine annelids; a generalisation of the Lamé equation; the Lepidoptera of North Bergen county; physical conditions and plankton of Puddle fiord.

IN a memoir which appears in the *Proceedings* of the U.S. National Museum (vol. xx. pp. 1-421, 1897), Mr. S. H. Scudder describes in detail and discusses the classification of a group of grasshoppers which forms the prevailing type of orthopteran life throughout North America—the short-horned grasshopper commonly seen in the United States, its best-known representative to the world at large being the destructive migratory Rocky Mountain Locust. The title of Mr. Scudder's paper is "Revision of the Orthopteran Group Melanopli (Acridiidæ), with special reference to North American forms."

THE natural history societies of our public schools deserve encouragement, for they create interest in natural things and phenomena, and lead inquiring minds to make observations for themselves. The reports of three such societies, namely those of Rugby, Wellington, and Cheltenham, showing the results of observations, and containing abstracts of lectures, have been received, and each of them is a creditable production. Among

the papers which call for special attention is an essay upon the birds of the Oxford district, by Mr. F. Sidgwick, in the Rugby Society's report; and one on birds and birds-nesting, by Mr. C. Montford, in the Cheltenham Society's report.

Archæologists will be interested in a paper on "Dwellings of the Saga-time in Iceland, Greenland, and Vineland," by Cornelia Horsford, which appears in the *National Geographic Magazine* (March). The Saga-time began with the colonisation of Iceland in 875, and lasted for about 150 years, but little definite knowledge exists as to the forms of the dwellings in those days. The paper is illustrated by plans of Norse ruins (so far as they are known) in Iceland and Greenland, and of a supposed Norse ruin in Massachusetts. It will enable a comparison to be made between the different dwellings of the Northmen and those of the native tribes of North America, from the magnificent ruins of Copan to the long, narrow houses of the Iroquois.

Prof. William Somerville's sixth annual report on experiments with crop and stock in the counties of Cumberland, Durham and Northumberland, provides an excellent example of useful technical education assisted by County Councils. In the work of agricultural demonstration described in the pages of the report, the Durham College of Science was associated with the Councils of the counties above referred to, and the information given will be distinctly valuable to the agriculturists of these counties. Of especial importance are the results of rotation experiments which have been carried on for four years on three Northumberland farms. The results obtained at these stations are tabulated, but the detailed discussion of the rotation experiments has not yet been completed.

The fourth number of "The Psychological Index"—a bibliography of the literature of psychology and cognate subjects for 1897, compiled by L. Farrand and Howard C. Warren—is a most useful publication for psychologists. The papers are well classified, and there is an index of authors; so it is easy to find what contributions have been made to the various branches of the science, and what the various investigators have done. There are 2465 titles in the Index, thus indicating considerable activity in psychological science. The Index is issued in connection with the *Psychological Review*, which is published bi-monthly by the Macmillan Company.

A *Bulletin* (No. 13, new series), containing a compilation, by Dr. L. O. Howard, of recent laws and regulations against injurious insects, and especially the San José scale, has been issued by the U.S. Department of Agriculture. The information given will be of interest to persons engaged in trade with living plants, and to horticultural and agricultural societies and others wishing to propose legislation of the kind described. Another *Bulletin* (No. 12), just issued by the U.S. Department of Agriculture, gives an account of the spread of the San José scale in the United States during the last two years, and of the work which has been done by economic entomologists in the effort to subdue it.

The latest phases of the controversy concerning the place where John Cabot first landed in North America four hundred years ago, are presented in a paper by Dr. S. E. Dawson, on "The Voyages of the Cabots," published in the *Transactions* of the Royal Society of Canada for 1897. Dr. Dawson concludes "that there is no physical or geographical reason *à priori* why Cape Breton may not have been Cabot's landfall, and that the voyage was intended to be upon a westerly course. It will also appear that all the conditions existing upon the North Atlantic tend to make a westerly course swerve to the south, and that there is, therefore, a strong preponderance of probability in favour of a landfall at Cape Breton." Positive evidence of contemporary documents is shown to point to the same conclusion.

Messrs. Masson and Co., Paris, will shortly publish the following works of science:—"L'Anatomie comparée des animaux basée sur l'embryologie," by Prof. Louis Roule; "Précis de Botanique médicale," by Prof. L. Trabut; "Eléments de Botanique," by Prof. Ph. van Tieghem.

Mr. T. R. Dallmeyer has just published a useful little book entitled "A Simple Guide to the Choice of a Photographic Lens." This book seems to be exactly suited to the requirements of a whole host of photographers, especially amateurs who prefer to have their information retailed concisely and simply by one who knows. A great feature of these thirty pages is the appeal to diagrams which illustrate more clearly than words many fundamental facts regarding lenses and their behaviour. Four excellent platino-bromide reproductions are inserted, to illustrate the capabilities of the author's new universal stigmatic lens, Series ii. F/6, which does the work of practically four ordinary lenses.

The firm of Gustav Fischer, Jena, announces for early publication the following new works and new editions:—"Ueber Herzbewegung und Herzstoss," by Dr. Ludwig Braun. This volume will contain the results of an experimental study of movements of the heart, analysed by means of a kinematograph.—"Die Bakteriologie in der Milchwirtschaft," by Dr. E. von Freudenreich.—The second part of Dr. Oscar Hertwig's work on "Die Zelle und die Gewebe," dealing with the general anatomy and physiological properties of the tissues.—"Beiträge zur Klinik der Rückenmarks-und Wirbeltumoren," by Dr. H. Schlesinger.—The first section of "Mitteilungen aus der Augenklinik," by Dr. J. Widmark.—The fourth enlarged edition of Dr. Robert Wiedersheim's "Grundriss der vergleichenden Anatomie der Wirbeltiere."

The Chemical Publishing Company, Easton, Pennsylvania, has published a second, thoroughly revised edition of "Laboratory Experiments on the Class Reactions and Identification of Organic Substances," by Dr. A. A. Noyes and S. P. Mulliken. A sixth edition of Mr. P. McConnell's serviceable "Notebook of Agricultural Facts and Figures for Farmers and Farm Students" has been published by Messrs. Crosby Lockwood and Co.—The present state of knowledge of Röntgen radiation and its practical applications is well stated in the second edition of "Practical Radiography" by A. W. Isenthal and H. Snowden Ward, published by Messrs. Dawbarn and Ward. Many of the illustrations in the book are very fine.—A revised and enlarged edition (the sixth) of Messrs. Marion and Co.'s well-known "Practical Guide to Photography" has just been issued.

The additions to the Zoological Society's Gardens during the past week include four Silver Pheasants (*Euplocamus nycthemerus*) from China, presented by Mr. H. J. Veitch; a Common Barn Owl (*Strix flammea*), captured at sea, presented by Captain George Innes; a Black-winged Peafowl (*Pavo nigripennis*, ♂) from Cochin China, presented by Mr. Richard H. J. Gurney; four Undulated Grass Parrakeets (*Melopsittacus undulatus*) from Australia, presented by Mr. Aitchinson; a Black-bellied Sand Grouse (*Pterocles arenarius*) from Asia, a Pin-tailed Sand Grouse (*Pterocles alchata*), South European, a Rosy Bullfinch (*Erythrospiza githaginea*) from Algeria, presented by Mr. E. G. B. Meade-Waldo; two Common Bluebirds (*Sialia wilsoni*) from North America, two Yellow-bellied Liothrix (*Liothrix luteus*) from China, an Amaduvade Finch (*Estrelda amandava*) from India, a Red-bellied Waxbill (*Estrelda rubriventris*), a Crimson-eared Waxbill (*Estrelda phœnicotis*) from West Africa, presented by Miss Edith M. Kemp Welch; four

Amaduvade Finches (*Estrelda amandava*), a Green Waxbill (*Estrelda formosa*), two Black-headed Finches (*Munia malacca*), two Chestnut-bellied Finches (*Munia rubro-nigra*), three Indian Silver-bills (*Munia malabarica*) from India, a Common Waxbill (*Estrelda cinerea*), three Orange-cheeked Waxbills (*Estrelda melpoda*), two Red-bellied Waxbills (*Estrelda rubriventris*), a Paradise Whydah Bird (*Vidua paradisea*), a Grenadier Weaver Bird (*Euplectes oryx*) from West Africa, three Banded Grass Finches (*Poëphila cincta*) from Queensland, a Bar-breasted Finch (*Munia nisoria*) from Java, a Maja Finch (*Munia maja*) from Malacca, a Chestnut-eared Finch (*Amadina castanotis*) from Australia, presented by Miss Petrocochino; two Black Rats (*Mus rattus*) from the Channel Islands, presented by Mr. J. Ernest Ardron; a Common Otter (*Lutra vulgaris*), British, presented by Mr. A. P. Ashburnham; three Hairy-footed Jerboas (*Dipus hirtipes*) from North-east Africa, presented by Miss Baird; a Green-cheeked Amazon (*Chrysotis viridigena*) from Colombia, deposited; a Collared Fruit Bat (*Cynonycteris collaris*), a Yellow-cheeked Lemur (*Lemur xanthomystax*), a Crested Porcupine (*Hystrix cristata*), two Squirrel-like Phalangers (*Petaurus sciureus*), a Red Kangaroo (*Macropus rufus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY:—

May 2. 11h. 24m. to 12h. 11m. B.A.C. 4006 (mag. 5·7) occulted by the moon.
2. 21h. Jupiter in conjunction with moon. Jupiter 6° 58′ N.
6. Vesta (mag. 6·5) in opposition to the sun. In Libra.
7. 6h. 36m. α Scorpii (Antares) in conjunction with moon. α Scorpii, 1¼° S.
7. 12h. Saturn in conjunction with moon. Saturn 5° 7′ N.
11. 13h. 16m. to 13h. 51m. B.A.C. 7263 (mag. 6) occulted by moon.
13. Uranus 52′ S. of β Scorpii (mag. 3).
15. Venus. Illuminated portion of disc 0·923.
15. Mars. ,, ,, ,, 0·936.
18. 18h. Venus in conjunction with Neptune. Venus 2° 19′ N.
20. Saturn. Outer minor axis of outer ring, 18″·69.
20. Ceres 16′ N. of β Geminorum (Pollux).
22. 4h. Uranus in opposition to the sun. In Scorpio.
22. 6h. 54m. to 7h. 32m. Venus occulted by moon.
24. Encke's Comet arrives at perihelion.
29. 22h. Saturn in opposition to the sun. In Scorpio.
30. 5h. Jupiter in conjunction with moon. Jupiter 7° 1′ N.

DOUBLE AND MULTIPLE SOUTHERN STARS.—The observation of double and multiple stars in the southern heavens has never been attempted on a large scale, although several observers have turned their attention to these bodies with not very large apertures. Sir John Herschel, in his southern sweep for nebulæ and clusters, was enabled to detect over 2000 new double stars; but his chief interest was more for the close examination of the former celestial objects than for the search for double stars. Since that time the Sydney Observatory, the Cape Observatory, and the Harvard observers at Arequipa have done much to promote our knowledge of this class of southern stars. A search on a large scale has recently been undertaken by Dr. T. J. J. See, who was invited by Mr. Lowell to undertake a survey of the southern heavens for the discovery and measurement of new double stars and nebulæ with the 24-inch refractor, which had just been completed by the Clarks. In the *Astronomical Journal* (Nos. 431–432) Dr. See gives us some details of his plan of work, together with the first part of the catalogue of new double stars. In this survey Dr. See was aided by Mr. Cogshall. The observing station was first at Mars' Hill, Flagstaff; next in Mexico, in the western part of Tacubaya; and then again at Flagstaff, the telescope in each case being dismounted and re-erected.

The region of the sky embodied in this work includes the entire zone between −20° and −45°, and the more southern region swept over in Mexico lies between −45° and −65° between 4h. and 16h. Right Ascension. Dr. See states: "In the course of this work it is certain that we have examined carefully not less than one hundred thousand stars, and many of them doubtless on several occasions." All the star places have been referred to the equator and mean equinox of 1900·0, and in each case the colours are given after a terminology which was found best to describe the tints of the spectrum. To give an idea of the quality of the object-glass used, and the excellent atmospheric conditions at Flagstaff, we may mention that an object was not considered difficult unless it was below 0″·3, or fainter than the 14th magnitude for fairly wide objects. Dr. See proposes to arrange the final catalogue in two parts: the first giving the new doubles, and the second doubles recognised by previous observers. He further uses the symbol λ to denote "stars discovered at the Lowell Observatory," and an index 1 being affixed to this letter in the first catalogue, and other numbers in subsequent catalogues. When completed, this great work will prove a most valuable contribution to our knowledge of many interesting systems in the southern hemisphere.

COMET PERRINE.—The following is a continuation of the ephemeris given previously in this column:—

12h. Berlin Mean Time.

1898.	R.A. h.	m.	s.	Dec. °	′	log *r*	log Δ	Br.
April 28	0	20	32	+49	28·1			
29		25	59	49	56·0			
30		31	26	50	22·6	0·1171	0·2675	0·52
May 1		36	53	50	48·0			
2		42	21	51	12·3			
3		47	49	51	35·4			
4		53	16	51	57·4	0·1285	0·2799	0·47
5	0	58	43	+52	18·3			

THE MANORA OBSERVATORY.—In a recent number of the *Naturwissenschaftliche Wochenschrift* (Band xiii. No. 14), Herr Leo Brenner gives a condensed account of the observations made at the Manora Observatory during the past year. As usual, the observations are chiefly restricted to minute examinations of the surface markings of planets. The article is illustrated by reproductions of the observatory and instruments and drawings of the surface markings of some of the planets. Herr Brenner refers to the question that has been raised regarding the financial condition of the observatory. In his concluding remarks he adds: "For the main part my work this year will depend on whether a change occurs in the financial condition of the observatory, or whether I shall be obliged, as formerly, to waste my time in writing worthless scientific articles."

THE HARVARD COLLEGE OBSERVATORY.—The fifty-second annual report of the director of the Astronomical Observatory of Harvard College gives us an idea of the immense amount of work which is being carried on so successfully under his supervision. Not only are extensive investigations undertaken, but they are brought to completion by the liberal staff with which he is provided. After referring to the large endowment for current expenses which renders such assistance possible, Prof. Pickering adds that as regards permanent plant they are far behind other observatories even of the second class. That this will be soon remedied there is no doubt; and Prof. Pickering has the happy faculty of knowing from which direction such donations will come, for he says, "the need of modern buildings is most likely to be supplied by gifts or bequests from persons whose names should be attached to them. For instance, a library building in which the clerical work of the institution could be performed is greatly needed. A modern machine-shop to replace our present workshop would form an excellent memorial of one who had been interested in the application of the mechanic arts to scientific uses." As usual, each of the instruments has been used for extensive investigations. The east equatorial has been employed for photometric light comparisons of variables mostly with the new polarising photometer, while the west instrument has been used for similar observations of variables and comparison stars. The meridian circle and meridian photometer have also been continuously employed, Prof. Pickering having worked with the latter on 152 nights, and made 100,052 photometric settings. The researches planned for this latter instrument are, we are told, approaching completion, 860,000 measures of about 40,000 stars having been made during the last twenty years. Both the 8-inch telescopes have been used for photographing stellar spectra, the number of photographs

obtained being 6054. The 11-inch Draper telescope has been employed for photographically recording the satellites of Jupiter undergoing eclipse, and variables of the Algol type. Mr. King, who has been investigating the effects of differential refraction and flexure on the form of the photographic images, has found that an equatorial should never be driven on sidereal time, but that satisfactory images have been obtained by photographing at suitable hour angles with a mean time driving clock, the rate being wholly corrected by the refraction in right ascension. Experiments are now being made to introduce a flexure correction automatically. In this connection it is interesting to refer to the work done by Dr. Rambeau. With regard to the other departments under the direction of Prof. Pickering, we must limit ourselves here to mentioning them: namely, the Boyden department at Arequipa, where the new Bruce photographic telescope has been erected, and the Blue Hill Observatory, although they have both been contributing valuable observations during the last twelve months.

THE NATURE AND HABITS OF PLINY'S SOLPUGA.

ALTHOUGH next to nothing is known of the past history of the spider-like creatures discussed in the following pages, it is tolerably certain that since glacial times they have been confined in their distribution, so far as Europe is concerned, to Spain, Greece and South Russia. Since, therefore, they were certainly unknown to our British and Anglo-Saxon ancestors, and probably also to the early Romans, it is not surprising that the English language has no name for the group of which they are members. To the ordinary Englishman they are spiders, and as spiders or tarantulas they are usually described by travellers who have come across them in India, Egypt and elsewhere. The Greeks, on the contrary, who were doubtless acquainted with the species inhabiting their own country and Asia Minor, seem to have recognised them from the ordinary spider, since they had a distinctive name for each of the two groups. The spiders were called Arachne (ἀράχνη); the others Phalangium (φαλάγγιον), in allusion to their five pairs of long-jointed limbs. Ælian, for example, tells how a country in Æthiopia was deserted on account of the appearance of incredible numbers of Scorpions and Phalangiums. But Pliny, when quoting the same story, introduces Solpuga[1] in place of Phalangium. And since the latter is now used in systematic zoology for a totally different group, namely for the so-called Harvest or Long-legged Spiders, so abundant throughout Europe, no further reason need be given for adopting Pliny's name for the species now under discussion.

So much by way of preface. But before leaving the ancient history of the Solpuga, it may be interesting to mention a suggestion that has been made to the effect that the Hebrew word translated Mouse in the Old Testament referred to some sort of Solpuga; and that the sores, the emerods (hæmorrhoids), from which the Philistines suffered, resulted from the bites of these creatures. In support of this supposition may be urged the unmistakable resemblance to mice presented by some of the smaller, dark-coloured, short-legged species, with their hairy bodies and rapid movements, which occur both in Egypt and Syria; and the statements of travellers to the effect that at the present time they inflict painful bites upon people when asleep in the desert at night.

It is beyond the scope of the present article to deal with the many points of interest connected with the anatomy of these animals. Nor is it necessary to point out all the distinctive features which serve to separate them from the true spiders, the only members of the class Arachnida with which they are likely to be confounded. Suffice it to say that the term spider, doubtless a corruption of spinner (spinster), is technically applied exclusively to the familiar web-spinners, and that no silk glands exist in any members of the order Solifugæ.

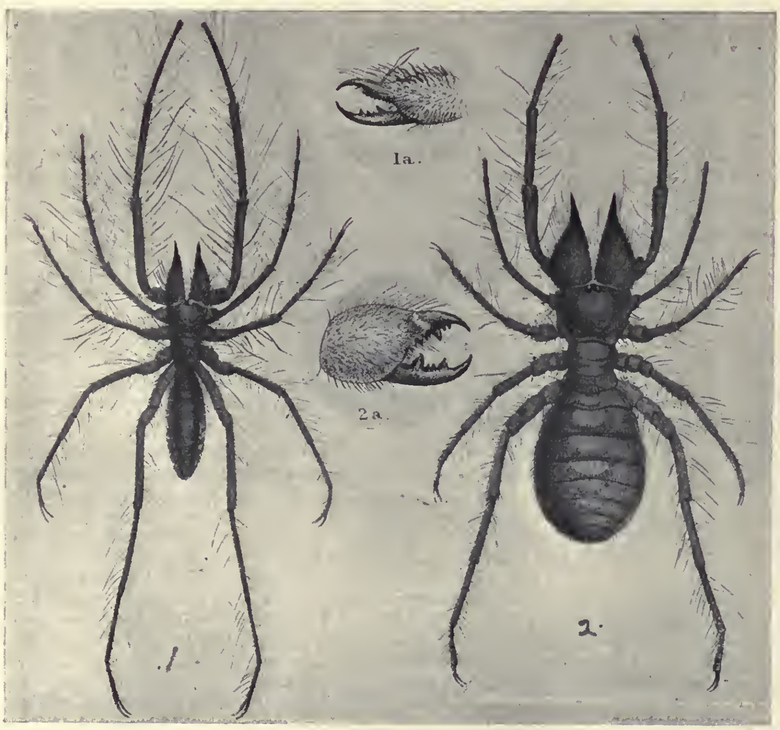

FIG. 1.—Indian Solpuga (*Galeodes fatalis*).—1, male; 1*a*, jaw of male seen from the side; 2, female; 2*a*, jaw of female seen from the side. (Figs. 1 and 2 reduced to three-fourths the natural size)

The general form is well shown in the annexed illustration depicting the male (Fig. 1) and the female (Fig. 2) of a North Indian species called *Galeodes fatalis*. As will be seen, the sexual differences are very striking, the male being both smaller and lighter in build, with the head narrower and the jaws less bulky; the legs, on the contrary, are unmistakably longer. This correlation between lightness of body and length of limb points to much greater activity on the part of the male, a superiority which no doubt stands him in good stead at the pairing time, when the female has a habit, it is alleged, of killing and devouring her less powerful mate. Again, in addition to being smaller, the jaws of the male (Fig. 1*a*) are always less strongly toothed than those of the female (Fig. 2*a*), and are furnished on the upper side with a peculiar organ of unknown function called the *flagellum*.

In both sexes, but especially in the female, the jaws attain a development unequalled elsewhere in the class Arachnida (Spiders, Scorpions, Solpugas, &c.). They are, in fact, admirably adapted for the purpose of crushing hard-shelled beetles and other insects. But they also have another duty to perform, namely, that of digging; for the females, at least at the breeding season, excavate subterranean burrows for the protection of themselves and their young. The process has been observed in the case of the species here figured. Choosing a suitable spot, the female proceeded to cut away the earth in a circle with her jaws, then kicked away the loosened fragments with her legs, or scraping them together into a heap with the palpi [the long front pair of legs], pushed the pile by main force from the entrance of the burrow. At its opposite end the eggs, about fifty in number and resembling a mustard-seed in size and shape, were laid, and hatched about a fortnight afterwards. For

[1] This word is, perhaps, a corruption of *Solifuga* or *Solipugna*, which seem also to have been in use. The former means a creature which flees from the sun; the latter one that battles against it, and so hates or is intolerant of it.

three weeks the young showed no sign of movement. They then moulted for the first time and started to crawl about on their own account, little copies in miniature of their mother, who mounted guard at the entrance and resolutely repelled all intruders, snapping without hesitation at every object thrust into the burrow.

Some species of Solpuga are known to be diurnal, and have been met with roaming abroad in the full glare of the tropical sunshine. From this habit they are known to the Spaniards of Santiago as "Arañhas del Sol" (sun-spiders). For the most part, however, they are nocturnal, and in certain localities favourable to their development prove a great nuisance to travellers camping out. Olivier, for example, describes how they would come into his tent in Mesopotamia at night, attracted by the light; and Mr. Guy Marshall informs me that an acquaintance of his, when encamped on the Hartley Hills, Mashonaland, was forced to shift his quarters on account of the invasion of his tent by a number of enormous spiders, evidently, from his description, a large Solpuga, which entered at night when the lamp was burning and rushed about at lightning speed. In such occurrences as these is doubtless to be found the substratum of truth upon which Ælian based his story of the desertion of the tract in Æthiopia on account of the Scorpions and Phalangiums.

Nothing in the way of animal life, provided it be of suitable size, comes amiss as food to the Solpuga, which is strictly carnivorous in diet. It is true that stories are told of the killing and eating of small vertebrates, like lizards, mice, birds, and bats. Nevertheless the staple article of their diet no doubt consists of insects of various kinds, ranging in size from ants to moths, beetles, or grasshoppers. A species which frequents the houses in Denver, Colorado, is said to be of service to mankind on account of its partiality for bed-bugs, a fact of some interest as showing that the strong stench of cyanide of potassium emitted by these parasites is no protection against the attacks of the Solpuga. Another kind living in Mashonaland, and known as *Solpuga sericea*—an elegant little species striped black and yellow, with long silky white hairs upon the hind legs, which, when running, resembles a tuft of thistle-down blown before the wind—feeds largely upon white ants; though Mr. Guy Marshall, my informant concerning its habits, has noticed that they eat jumping spiders of the family Attidæ, as well as small moths and beetles. When searching for food they may be seen running about at a great pace in the hot sunshine, and every now and again stopping to rest for a few seconds beneath the shade of a stone or leaf, only to rush off again without the least warning. Often when going at full speed they will stop abruptly and begin hunting and feeling around a small spot, irresistibly calling to mind the behaviour of a dog checked in mid-course by the scent of game. The white-ants they feed upon belong to a species which, instead of making a mound, builds mud tunnels along the surface of the ground amongst dead-leaves and sticks. Upon discovering such tunnelling the Solpuga follows it up, carefully examining it all the way, then suddenly breaks through the mud-wall and extracts a white ant. But whether the proximity of the insect is discovered by hearing or scent is at present unknown. This species is an expert climber, and has been seen to ascend trees to some height above the ground in search of prey. Similar stories are told of the climbing powers of other species from different parts of the world; and Mr. A. Carter informs me that in Egypt it is no uncommon thing to see a Solpuga (*Galeodes arabs*) climbing on to a table to get at the flies. To capture such quick and wary insects the Solpuga adopts the tactics of the hunting-spider; instead of making a furious dart, as it would if the prey in sight were a beetle, it proceeds to stalk the flies in the most wary fashion, creeping towards them with such slowness and stealth that the movements of the legs are almost imperceptible, yet all the while drawing gradually nearer and nearer; then like a flash of light the intervening space is traversed, and the insect struck down and captured.

Even in the case of so redoubtable an adversary as a scorpion, there is no hesitation on the part of the Solpuga in advancing to the attack. J. G. Wood tells us how at the outset of one such encounter the Solpuga by good fortune severed at one snap the scorpion's sting, and made short work of him afterwards. Nevertheless such an end to the contest is the exception rather than the rule; for in addition to some evidence on this head supplied by Mr. Trimen, Mr. Carter informs me that he has repeatedly witnessed encounters in Egypt between the common Solpuga (*G. arabs*) and the sand-scorpion of that country (*Buthus quinque-striatus*); but though the two are well matched for size, the scorpions never came off second best, in spite of the incomparable advantage in point of activity enjoyed by their adversaries.

Striking is the difference in appearance between a Solpuga fasting and a Solpuga full fed. In the former the abdomen shrivels up, the segments shrinking one within another like the several pieces of a half-closed telescope; in the latter the expansion is carried to such an extent that the distended abdomen much resembles a short thick sausage, far surpassing in size and weight the rest of the body and limbs. This is brought about by the imbibition of water and of the fluid and semi-fluid tissues of their prey. In support of their water-drinking propensities, the following passage, written by the Soudan war correspondent to the *Standard* (October 19, 1897), may be cited: "One day in my tent [at Kerma] I heard a rustle like that of a silk dress. A big, ugly, yellow hairy beast, with nippers like a crab, was moving fast as a mouse over the moist ground near the zeer [porous water jar] in the corner of my tent. At last he settled down to suck the water from the sides of the jar." The writer of the passage just quoted had previously spoken of this animal as the "famous abu-shabat, the terror of the Soudan in the way of spiders, as large as your hand and ten times more venomous than a scorpion."

This question of the poisonous nature of the Solpuga's bite is one that has attracted much attention. There is no doubt, however, that in the strict sense of the word they are not venomous at all. Nevertheless the jaws of the larger species are capable of giving a nasty and painful bite, and it is intelligible that a severe sore of long duration might result from such a wound if the Solpuga had been previously feeding upon septic matter, or if the sufferer were at the time addicted to scurvy or were in a weak state of health from any other cause. This, quite apart from other reasons, is sufficient explanation of the fact that the native inhabitants of almost all the countries where these animals are found look upon them with horror and fear on account of their alleged ferocity and venom. The natives of Somaliland, however, seem to be an exception to the general rule, for although the Solpugas are remarkable for size and abundance in that country, the Somalis, writes Mr. Parkinson, do not regard them as noxious, and have no names for things so unimportant. The dwellers in Baku on the Caspian, on the contrary, declare the Falangé [*Galeodes araneoides*] to be especially poisonous after emerging from its winter sleep, and, according to Mr. Rowland, believe that to counteract the effects of the poison it is necessary to rub the wound with the carcase of the Solpuga after first steeping it in boiling oil. Perhaps it is needless to explain to those who know the Asiatic that our subjects in Hindostan are firmly convinced of the deadly nature of the Jerrymanglum.[1] The opinion of these people on such a matter, however, is of no great value, as the following circumstance shows. Mr. H. R. P. Carter, when living at Madras, repeatedly, as he tells me, allowed the Solpuga, in the presence of natives, to bite his arm until the blood ran, without suffering anything worse than a passing pain from the wound. But although his experiments proved conclusively to himself the harmlessness of the bite, they were not sufficient to make the onlookers alter their judgment one whit. In confirmation of Mr. Carter's conclusion it may be added that Mr. J. ffolliott Darling has also had the fortitude to make similar experiments on himself, and has attained similar results, with species that are found in South Africa.

Of their enemies we know but little. From an observation made by Mr. Distant, who, while in the Transvaal, saw a wagtail attacking a specimen of *Solpuga hostilis*, a small species which is abundant in that country and in Natal, it may be inferred that they are eaten by insectivorous birds, and probably also by some mammals and reptiles. So, too, may it be supposed that the larger kinds of Solpuga destroy the smaller, and that all, both great and small, fall victims to large and medium-sized scorpions, to say nothing of great spiders and carnivorous ground beetles, many of which would certainly be powerful enough to overcome the weaker species.

It must be remembered, too, that although when fasting their agility is amazing, and their chances of escape correspondingly great, yet when gorged with food, as described above, and practically unable to trail their distended bodies behind them,

[1] This name for the Solpuga in the Tamil language I venture to spell as I have heard it pronounced.

they would fall easy victims to enemies much weaker and slower than themselves.

On the other hand, we learn from Dufour that the species found in Algeria are exempt from the attacks of the Mason wasps, which, as is well known, in that and in all countries fearlessly attack and destroy numbers of the largest spiders, and could, without difficulty, catch the fleetest Solpuga in the world. The reason for this freedom from persecution is not quite clear, unless it is to be explained by the fact that the Solpuga is too formidable a foe for the wasp to tackle. That this may well be the case is rendered intelligible by the reflection that the large lycosiform and mygaloid spiders fall easy victims because, owing to feebleness of vision and lack of activity, they are not quick enough to elude the final swoop of the wasp. The Solpugas, on the other hand, as compared with the spiders, are exceedingly agile and keen-sighted. Moreover, when on the defence, they have a habit, as described by Dr. Walter, of turning up the abdomen, so as to protect that vulnerable part, and extending the legs forwards and upwards in such a way as to present to the foe a pair of gaping jaws surmounted by five pairs of strong limbs armed with long bristles, stout spines and sharp claws. Small wonder if under the circumstances the wasps think discretion the better part of valour.

The last peculiarity to be mentioned is the presence on the inner surface of the jaws of some strong horny ridges, which by mutual friction emit a harsh grating noise. In some genera these ridges are scarcely at all developed: in others they are very pronounced. That the sound is produced in the way described under the stimulus of sudden fear or irritation was long ago pointed out by Hutton, and even before him by Pallas; and, touching its function, one can only suppose that, like analogous organs found in the rattlesnake and in some of the largest spiders and scorpions, it acts as an advertisement of the whereabouts of the Solpuga, and as a warning to enemies to keep a respectful distance. R. I. Pocock.

THE LABOULBENIACEÆ: A NEW FIELD OF STUDY AMONG FUNGI.[1]

The knowledge of most botanists of the group of Fungi here under treatment is probably confined to the brief description given of them by De Bary, under the head of "Doubtful Ascomycetes," where Peyritsch's figures of *Stigmatomyces Baeri* are reproduced.

Since 1884, when De Bary's "Fungi" appeared, the investigation of the group has, however, proceeded apace; and whereas at that time hardly more than a dozen species had been distinguished, Dr. Thaxter considers that no fewer than 150 species belonging to 30 genera are now known. Almost all of these additions are due to Dr. Thaxter's investigations, and have already been announced, from time to time, in a series of papers emanating from the Cryptogamic Laboratory of Harvard University.

The first to observe one of these Fungi was probably the entomologist Laboulbène, in whose honour *Laboulbenia rougetii* was named by Montagne and C. Robin. The earliest description came from Robin in the "Histoire Naturelle des Végétaux Parasites" in 1853. H. Karsten (1869) and Peyritsch (1871–75) followed with a more detailed treatment of the morphological characters of the group, and still later Berlese, Giard, Istvanffi, and Thaxter, have in turn added to our knowledge of the family.

The Laboulbeniaceæ are, without exception, entomogenous, and occur upon species of beetles and flies almost exclusively. They are attached to the chitin of the insect by only a minute foot, by means of which, however, they absorb all the nutriment they require for their development. Upon examination with a hand-lens, they have the appearance of hairs or bristles of a dark colour, standing out vertically from the substratum. As they seldom exceed half a millimetre in length, it is not surprising that they easily escape the notice of entomologist and mycologist alike.

Their morphological characters present features of unusual interest, inasmuch as they seem to exhibit a marked sexuality, and that of a peculiar type. The male cells are non-motile spermatia, arising for the most part endogenously, but in certain genera abstricted exogenously, as in the case of the Florideæ. These spermatia become attached to trichogynes, whose cell-wall appears to have the same gelatinous consistence as have those of the Florideæ. In some genera, these trichogynes become branched and multicellular; in a few cases they bend over to come into contact with spermatia *in situ*, and then straighten again, carrying off a detached spermatium. Bearing the trichogyne is a "trichophore," itself resting on a "carpogenous" cell. From this latter there are ultimately budded off four or eight asci, each containing, when mature, four or eight usually septate ascospores, the whole being enclosed in a fusiform fructification, recalling the perithecium of a Pyrenomycete. It seems impossible to resist the impression that the asci arise as the result of an act of fertilisation, though the details of the process have not been observed. That the Laboulbeniaceæ are to be included among Ascomycetes can no longer be doubtful, and their morphology, when considered in connection with the observations of De Bary, Janczewski, Stahl, and more recently Harper, lend support to the view that sexuality persists in this class of Fungi It is difficult to imagine how otherwise Brefeld can account for the structure of Laboulbeniaceæ, when his researches have extended thus far.

The similarity in the method of fertilisation with that existing in Florideæ is very marked. For the occurrence of a receptive trichogyne and detached non-motile spermatia among Fungi, Stahl's observations had already prepared us, though it has been denied that the structures called by these names in Collemaceæ, have the sexual significance they have been shown to have in Florideæ. The analogy of the similar organs in Laboulbeniaceæ with those of Florideæ would seem to be beyond doubt. A further startling analogy with Florideæ is found in the occurrence of a single conspicuous pit in the walls separating successive cells of the hyphæ; and, as in Florideæ, these have already been utilised in tracing the genetic connection of the cells of the thallus. Although Thaxter, on account of these similarities, does not regard the derivation of Laboulbeniaceæ from Florideæ, as unworthy of consideration, it is improbable that they indicate anything more than similarities of adaptation, which often occur in widely separated groups.

Of the 250 different species of insects on which these Fungi have been found parasitic, 241 are Coleoptera, and of these the majority are aquatic or riparian in habit. Of the 7 dipterous host-species one is the common house-fly, which is frequently infested with *Stigmatomyces Baeri* in the neighbourhood of Vienna. The single termite affected came from Africa, and the single acarid from Paraguay. Though most of the Laboulbeniaceæ yet described are exclusively North American, 19 European species are known, and some accompany their hosts into two or three continents. It is probable that the family will be found to be numerous in species, and widely distributed in range. No British locality for a single species is given in Dr. Thaxter's work, and no British writer seems to have yet made any contribution to the literature of the group. In Dr. Cooke's "Vegetable Wasps and Plant Worms," published in 1892, the species then described by Thaxter and others are enumerated, but no discovery of any of these in Britain seems to have been known to the author. It is highly improbable, however, that none of the parasites occur on any of the more than 3000 British species of Coleoptera.

Though these plants do not at present appear likely to become of any economic importance, yet it is clear that they are of exceptional morphological and physiological interest; and Prof. Thaxter has earned our gratitude for the persistence with which he has pursued their study, and for the ability and skill with which he has described and portrayed them. The work forms a worthy successor to the author's monograph on "The Entomophthoreæ of the United States." R. W. P.

[1] "Contributions towards a Monograph of the Laboulbeniaceæ." By Roland Thaxter. (*Memoirs* of the American Academy of Arts and Sciences, vol. xii. No. 3, December 1896. Pp. 242, pls. 26.)

THE BOLOMETER.[1]

In the number of the *American Journal of Science* for March 1881, there appeared an article descriptive of the actinic balance (since called the Bolometer), an instrument which has gained acceptance among physicists as a useful aid in the study of radiant heat. It was, it may be remembered, originally devised by the writer to discriminate the heat in any small portion of the grating spectrum, but it has since found wider applications.

[1] Reprinted from the *American Journal of Science*, April. (Communicated by the Author.)

As at first constructed, the strips, representing arms of the Wheatstone bridge, were made of iron from 0·001 to 0·0001 of an inch in thickness. The instrument was, even under these initial conditions, very many times as sensitive as the best thermopile the writer then possessed, but there does not appear to be any definite statement as to the exact sensitiveness in its early form.

In the article referred to, however, the instrument is represented as giving a deflection of about 40 scale divisions (millimetres) from the lunar heat, concentrated by a thirteen-inch lens, and it was sufficiently accurate to give a probable error of rather less than one per cent. for a single observation on a constant source of heat, so that the accuracy of the bolometer (quite a distinct consideration from its sensitiveness) was even then as great as that of the best photometric process. The galvanometer in use at that time was one of the early Thomson pattern made by Elliott.

The first bolometers were made by the writer's own hands. Subsequently the strips were usually cut out from sheets of thin platinum, and in one or two instances made from flatted wire, the strip of the linear bolometer at that time (about 1883) being usually about 10 millimetres long; anywhere from 0·001 to 0·01 of a millimetre thick, and, according to its special purpose, being made from 1 millimetre to 0·1 millimetre wide.

About 1886 the mounting of the instrument had been improved by the writer, so that the strip appeared like the vertical "wire" of a reticule in the focus of a positive eyepiece. It was also movable in some cases by a micrometer screw, and was, in fact, a micrometer thread controlled in the usual way, but endowed with the special power of feeling the radiations from any object on which it was directed.

In the earliest spectrum work the bolometer developed another important quality, its "precision." This quality is quite independent of the accuracy with which it repeats measures of radiation or any constant source of heat, and concerns the precision of setting, as a micrometer thread. It could, even twelve years ago, be pointed, not only like the thermopile, within a fraction of a degree of the place of the source of radiation, as for instance on a bright line in the spectrum, but within a fraction of a minute of arc.

The instrument of course depends for its general efficiency on the galvanometer with which it is connected. That used in 1886[1] had several improvements due to the suggestions of Sir William Thomson and Prof. Rowland, and was perhaps, at that time, the most effective instrument of its kind in use for such a purpose, the mirror and needles having been specially constructed at the Allegheny Observatory. The mirrors were platinised by the kindness of Prof. Wright, and were at that time nearly a centimetre in diameter. The needles were hollow magnets made by Mr. Very of the Allegheny Observatory. For the damping mechanism of the older galvanometer, I had substituted a dragon-fly (*Libellula*) wing, in which nature offers a model of lightness and rigidity quite inimitable by art. At that time, when making a single vibration in 20 seconds, a deflection of one millimetre division of the scale at one metre distance was given by a current of 0·000,000,0005 amperes, the instrument as described being capable of recording a change of temperature in the bolometer strips of less than 0·00001 of a degree Centigrade. So much less than this could be observed by special precaution, that it might be said that this one one-hundred-thousandth of a degree was not only indicable but measurable by the apparatus, which was employed as described, in the determinations of the relations of n to λ for the rock-salt prism, and by which the infra-red spectrum was at that time followed by actual measurement, to a wave-length of rather over five one-thousandths of a millimetre.

Since then the bolometer has been used in various researches, of which some occasional account has been given in the *American Journal of Science*. (See numbers for November 1888, and August 1890.) During recent years it has been specially employed in making a bolographic map of the lower spectrum, the publication of which has been greatly delayed by conditions incidental to the relations of the Smithsonian Observatory with the Government, but which it is hoped will not be deferred much longer.

Without here entering into an account of the work done by it, I have thought that it might be of interest to give very briefly a statement of the present condition and form of the instrument itself, considered under three aspects.

[1] *American Journal of Science*, third series, vol. xxxii. p. 90, 1886.

(1) Its precision, or the degree of exactitude with which it can be set on a special point, as, for instance, on a line of the invisible spectrum, recognised by its heat radiation alone.

(2) Its accuracy, or its capacity for repeating the same measure of radiation under like conditions.

(3) Its sensitiveness, or capacity for detecting minute radiations.

The instrument which I will take as the subject of comparison with the earlier one as described in this *Journal* (August 1886), is now in use in a chamber automatically kept at a temperature constant within one-tenth of a degree Centigrade.

The strips, the essential part of the instrument, are in the present case made by Mr. C. G. Abbot, and are of platinum, the central one being rather less than 0·1 of a millimetre wide. (The case is now made of metal instead of ebonite, and is surrounded by a current of water).

It is quite possible to make bolometer strips much narrower, but this is less necessary with the employment of the long-focus, image-forming mirror, so that in the present case the strip is at such a distance that it subtends an angle of 3·4 seconds. Its angular aperture is in practice adapted to that of the slit, which, with the use of the long collimator employed by the writer, gives a capacity of pointing (pointing, that is, *in the dark*), with a probable error of little over a second of arc. Quite recently, owing to the use of a novel collimating system of two cylindrical mirrors proposed by Mr. Abbot, the slit, though at a moderate distance, can have an opening sufficient to avoid prejudicial diffraction effects, while subtending an angle of considerably less than one second of arc.

In the galvanometer, the use of the fine quartz threads and specially small mirrors, originally due to Mr. Boys, has lately been carried to what seems near the practicable extreme, the quite invisible thread being made some 30 centimetres long, the mirror 2 millimetres in diameter, and weighing but 2 milligrams, and its six needles, of proportionate weight and dimensions.

This system is now made to serve with a much shorter swing than that formerly employed. If we reduce it to a time of single vibration of 20 seconds, only for the purpose of comparing it with the values already given in the earlier form, we obtain the results submitted below.

Before giving them, however, it is to be mentioned that the apparatus at Washington is most unfavourably situated, owing to its being subject to tremor from the traffic of neighbouring streets and to other causes, which it has been the object of years of struggle to conquer. This has been so far done that the values presently to be given (which, it will be remembered, are only attainable in a chamber of constant temperature, with special precaution against disturbance from external tremor), can be counted on as real values, always obtainable under proper conditions, and, in fact, rather within than without the average working capacity of the instrument.

I here consider the bolometer as at present employed.

(1) With regard to its precision, or exactness of pointing. The old thermopile could be set on a portion of the spectrum only with an error of a considerable fraction of a degree. The linear bolometer as employed in 1886 could be set with a probable error of a fraction of a minute of arc. The bolometer as employed to-day, and moved through the spectrum by clockwork, can be automatically set with a probable error of a single observation of little over a second of arc, can be set, that is, in the dark with a precision little inferior to the capacity of the eye in setting a micrometer thread in the light.

(2) As to its accuracy. I have had occasion recently to take a series of measures of successive throws of the galvanometer, using as a source of heat an Argand petroleum flame in a common student's lamp. I had no photometer at hand, but taking the usual statements of the text-books as to the accuracy of vision, it might be expected that such measures with the eye would give a probable error of about one per cent. (This is where sources of light of similar quality are compared.) The probable error of a single galvanometer reading was between 0·03 and 0·04 of one per cent., and this included the fluctuation of the intensity of the source of radiation, and the error of estimating tenths by the reader on the scale, both quantities of nearly the same order as the error in question. It seems safe to say, then, that *no* error attributable to inaccuracy of the bolometer could be detected by the means employed.

(3) As to sensitiveness. In the early work, for a time of single swing of 20 seconds, a deflection of one millimetre with

the scale at a metre's distance was obtainable with a current of 0·000,000,0005 of an ampere. At present, under such circumstances, a similar deflection would be obtained with 0·000,000,000,0012 ampere, that is to say, the apparatus is about 400 times as sensitive as it was when first described.

At present the bolometric apparatus, under the conditions already cited, will indicate a change of temperature in its strips of, at any rate, much less than one-ten-millionth of one degree Centigrade.

S. P. Langley.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Mrs. Phebe Hearst has offered to erect for the University of California a new building for the School of Mines.

Draughtsmen and engineering students familiar with the principles of the science of steam, are given opportunity of advancing their knowledge by a special class in steam-engine trials which will commence at the South-Western Polytechnic, Chelsea, on May 17, and terminate on June 28. The class will be conducted by Mr. W. W. F. Pullen and Mr. H. A. Clark.

The trustees of Cornell University have just established a Medical Department and a State College of Forestry. The medical department will be situated in New York City, and its faculty will be made up principally of those surgeons and physicians who have heretofore been connected with the medical department of New York University; including all but three of the instructors of that department. The endowment of the new medical school is by a donor whose name is not disclosed. The College of Forestry established by Cornell University will be situated at Ithaca, and called the State College of Forestry, having been authorised and endowed by the State with a grant of 10,000 dollars by the legislature which adjourned a few days ago. Prof. Bernard E. Fernow, director of the United States Division of Forestry, has been made director of this department.

One of the most important educational problems at the present time refers to the coordination of the work of the University and Technical Colleges with that of other educational institutions in the neighbourhood. It is unfortunate that in several cities the educational institutions are competing with one another instead of working together as an organic whole, in which each part has a definite function to perform. Efforts are, however, being made in the large provincial centres to prevent the undesirable overlapping which at present exists, in order to make the various educational institutions complement each other's work without competition. Summaries of what has been done in this regard at Birmingham, Manchester, Plymouth, and Sheffield appear in the current number of the *Record of Technical and Secondary Education.* In Birmingham, though no formal machinery exists for the coordination of educational work, the various institutions have adapted their organisation to the circumstances of their environment, supplying any need that was felt, and avoiding duplication of function. An educational ladder has, in fact, been constructed, up which a boy may climb from the Board School to the highest University honours without exciting the jealousy of other schools than those which he attended. This event actually occurred last year, when Mr. W. H. Austin, who began his education at a Birmingham Board School, came out Senior Wrangler at Cambridge. In Manchester the provisions for coordination take the form of an agreement between the Technical Instruction Committee of the City Council and the School Board, and between the authorities of Owens College and the Manchester and Salford Technical Schools. As between Owens College and the Technical Schools it is arranged that the latter shall aim at demonstrating how the general principles of science and art may be applied to the advancement of trade and industry, whilst the college will eschew these obviously bread-and-butter subjects, and address itself to the higher walks of pure science. In Plymouth, also, a scheme has been arranged which correlates and connects the whole of the science and art teaching of the town, from the infant school upwards. In Sheffield a scheme which secures the effective coordination and economical management of the Board Schools, the Technical School, and the School of Art, has been at work since last September, and appears to give entire satisfaction to all concerned; and Bradford has just taken steps to grade its various educational forces. Through all the schemes one main principle runs—that, namely, of making the common schools, Primary and Secondary, the kindergarten and nursery of science and art, and of making the Technical Schools true to their name as the places where is taught the application of science and art to the purposes of industry and commerce, while to the University Colleges are allocated the higher scientific studies. These examples should encourage other county boroughs to consider and adopt educational schemes which will prevent waste of effort and do away with conflicting interests.

SOCIETIES AND ACADEMIES.

London.

Physical Society, April 22.—Mr. Shelford Bidwell, F.R.S., President, in the chair.—A paper by Prof. T. C. Porter, on a method of viewing Newton's rings, was read by Prof. S. P. Thompson. If a parallel beam of light from a rectangular slit falls at oblique incidence upon a plane plate of glass, the first two reflections occur at the upper and lower surfaces of the glass, respectively, and give two corresponding images that may be formed on a screen. If now a second glass plate is added below the first, and parallel to it, at a short distance, four images of the slit appear on the screen. But when the lower plate is brought into contact with the upper one, the reflection from the lower surface of the upper plate follows the same path as that from the upper surface of the lower plate, so that only three images are now to be distinguished. For the two glass plates the author substitutes a "Newton's rings" apparatus, and by the above device for eliminating a set of reflections he is able to restrict the illumination to the light that comes from the two interior surfaces. As thus observed, the colours of the rings are very brilliant. When the plates are very clean, the darkest area of the "black" spot has a sharply-defined edge, similar to that of the black film of a soap-bubble. By using monochromatic light, the various sets of rings may be photographed; they appear as several systems of concentric circles, the systems intersecting one another. This method of illumination by a slit, enables Newton's rings to be viewed free from all light except that due to reflections at the bounding surfaces of the air-space between the plates. It reveals to the eye the subordinate interference-systems that coexist with the primary rings, and it demonstrates which of these reflections must be taken into account in the theory of the phenomenon. Moreover, it supplies a means for analysing these systems, and it indicates that the interference of monochromatic light is never complete under these circumstances. Prof. Herschel said it was rather difficult to follow the arguments of the author without witnessing the phenomena. Much complication was introduced by the successive reflections; it was not clear what became of them. There was no doubt as to the advantage of a narrow slit for the illumination. He thought some of the secondary reflections might be got rid of by using plates that were slightly prismatic. Prof. Thompson had, in his own laboratory, verified the advantages of the author's method of illumination. The result was a very sharply-defined first system of rings. Curves of subordinate interference were easily to be observed by this arrangement. Prof. Boys noticed in the photograph of the ring-systems that the independent systems of bands were distorted at the points of intersection. The intersecting curves formed a sort of honeycomb, or hexagonal system, instead of a system of curvilinear quadrilaterals. This distortion reminded him of similar effects observed in the photographs of "ripples." Mr. Edser said he had often noticed similar distortions, but he had always been able satisfactorily to explain them as being the result of imperfect focussing. The author had referred to the fact that a thin film when viewed by reflected light appears black. A phase-change of half a wave-length takes place either on reflection at a rarer, or at a denser medium; but there is no information from which to decide between these two alternatives. The truth of the assumption that the phase-change occurs at the denser medium seems to depend, so far as experimental evidence is concerned, upon the observation that in Lloyd's bands the central one is black. To produce the Lloyd's bands only one mirror is used; the bands produced by Fresnel required three mirrors. Wernicke performed an interesting series of experiments in which white-light reflected for various angles of incidence from a thin sheet of glass was examined spectroscopically. The spectrum was crossed by numerous black bands, and from the position of these bands in the spectrum the thickness of the glass was calculated. The calculated thickness when the angle of incidence was great, differed from that obtained with small angles of incidence; the conclusion was that when light is internally reflected, even at an angle of incidence less than the angle of

total reflection, a phase-change is produced. If the space between the two plates in Prof. Porter's experiment were filled with a substance of higher refractive index than glass, a confirmation, or otherwise, of this result might be obtained.—Dr. S. P. Thompson then exhibited a model apparatus made by the Helios Company to illustrate the three-phase method of transmitting power. It consists of a small generator, driven by hand, and a small motor. The generator may be separately excited by a secondary battery; it has three independent coils. The six ends of the coils are connected to six commutator rings. The motor has three corresponding pairs of opposite coils; these can be grouped in various ways for connection to the brushes of the generator. The six coils are on a hinged frame, so that, if necessary, they can be laid down flat, for other rotation experiments. Two armatures are provided, either of which may be used. The first is an iron wheel with peripheral copper bars arranged like a squirrel-cage; the other is a simple iron disc without added conductors.—The President proposed votes of thanks, and the meeting was adjourned until May 13.

Zoological Society, April 5.—Lieut.-Colonel H. H. Godwin-Austen, F.R.S., Vice-President, in the chair.—Prof. Sydney J. Hickson, F.R.S., read a paper on the species of corals of the genus *Millepora*. The author stated that thirty-nine species of the genus *Millepora* had been described. A prolonged investigation of the characters hitherto used for the determination of the species had proved them to be all unsatisfactory. An examination of the soft parts of a great many specimens of several forms of growth and from widely distant coasts had revealed no features that could be used for separating species. In the author's opinion, therefore, there was only one species of this genus now living, and that the individuals of this species were capable of assuming a great variety of form, according to the conditions in which they lived.—A communication was read by Mr. J. Stanley Gardiner containing an account of the perforate corals collected by him in the South Pacific. Fifty-one species were treated of, of which fifteen were described as new.—Mr. Oldfield Thomas read the description of a new Dik-dik allied to *Madoqua kirkii*, but much larger, which had been obtained by Mr. H. S. H. Cavendish in the region of Lake Rudolf, and was proposed to be called *Madoqua cavendishii*.—Mr. R. Lydekker, F.R.S., made some remarks on the geographical races of the Banting (*Bos sondaicus*), and suggested that the Burmese and Manipur forms of this animal should be given subspecific rank, for which he proposed the respective names of *Bos sondaicus birmanicus* and *B. s. woodi*.

Entomological Society, April 6.—Mr. R. McLachlan, F.R.S., Vice-President and Treasurer, in the chair.—On behalf of Mr. Greenshields, Mr. Jacoby exhibited specimens of the longicorn beetle, *Micropsalis durnfordi*, Burm., from Patagonia. Mr. Greenshields, who was present, stated that this species, remarkable for the great development of the palpi, was originally taken by Darwin; his own examples were taken hiding in thorny bushes in a dry watercourse.—Mr. Champion exhibited European examples of *Harpalus fröhlichi*, a newly-discovered British species.—Mr. B. O. Bower showed living larvæ of *Caradrina ambigua*, an insect which had recently occurred in England in countless numbers. They were bred from ova laid by a female taken on the South Devon coast, and fed indiscriminately on low plants.—Mr. M. Burr read a paper supplementary to Mr. Green's previous communication on *Dyscritina*, and definitely referred the imagos to the genus *Diplatys*, *D. longisetosa*, Westw., being a good species, and Mr. Green's new form proving to be *D. nigriceps*, Kirby.—Dr. Chapman read a paper on the larva of *Eriocephala allionella*, which he stated to be essentially similar to that of *E. calthella*, previously described by him.

Linnean Society, April 7.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. J. E. Harting exhibited specimens of the Asiatic partridge, *Perdix daurica*, of which a large consignment had been lately received in London. Mr. W. E. de Winton, who brought another specimen of this bird for exhibition, made some remarks on the geographical distribution of the species, and expressed the opinion that it had been improperly described by certain writers as Manchurian, its true habitat lying to the west of the Khinghan Mountains in Mongolia.—Mr. J. E. Harting also exhibited the skin and skull of a wild cat, *Felis catus*, recently obtained near Speanbridge, in Inverness-shire. He pointed out the present restricted range of the animal, which had not only disappeared entirely from England and Wales, but was no longer to be found in Scotland south of a line drawn from Oban to Ben Lui, along the southern and eastern boundary of Perthshire, and thence northward to Nairn. He explained the cause of reversion in the colour of emancipated house-cats to the wild type of *Felis catus*, and referred to the skulls of cats which had been exhumed on the site of the Roman city of Silchester, which he thought disproved the view of the late Prof. Rolleston (*Journ. Anat. and Physiol.*) to the effect that the domestic cat was not known to the Romans.—Dr. G. Elliot Smith read a paper, entitled "A contribution towards a more exact knowledge of the anatomy of the brain in Edentata." A full account of the brain of *Orycteropus* was first given, and comparisons were instituted with that of a dozen species representative of the leading Edentate families, including *Manis* and *Chlamydophorus*.—A paper was read by Mr. H. Farquhar, of Wellington, N.Z., on some New Zealand *Actiniaria*, in which he described a new genus, *Halcampactis*, and species *Halcampactis mirabilis*, together with the following new species: *Edwardsia elegans* and *neo-zelanica*; *Corynactis Haddoni*, *mollis*, and *gracilis*; and *Actinia tenebrosa*. *Halcampactis mirabilis* he regarded as of special interest, since it appeared to form a link between the *Sagartidæ* and *Halcampidæ*, which had hitherto been widely separated by systematists.

Royal Meteorological Society, April 20.—Mr. F. C. Bayard, President, in the chair.—Major H. E. Rawson, R.E., read a paper on anticyclonic systems and their movements. Cyclones and anticyclones have long been recognised as powerful weather controls, and their movements studied, but up to the present very little has been written in this country upon the progressive movements of the cores of the permanent high-pressure areas which are found to be associated with certain localities at different times of the year. The author referred to previous investigations by Abercromby, Scott, Loomis, H. C. Russell, and Buchan, and then proceeded to give the results of an examination which he had made of all the available synoptic weather charts for the eleven years 1881 to 1891. During this period there were 212 cases in which the centre or core of an anticyclonic system was over the British Isles, and of these 130 were due to the Atlantic system, 41 to the Scandinavian, and 17 to the Greenland, 22 to the Atlantic and Scandinavian systems extending and merging together, and 2 to the same thing occurring in the case of the Atlantic and Greenland systems. It is thus evident that we owe the greatest number of our anticyclones to the Atlantic system. They occur in all months, but more especially in January, June and October, and are least frequent in April and November. When such anticyclones move away from our area the direction is very much influenced by the season of the year, by far the largest number drift off in some direction between north-east, through east to south, and take the more southerly course in December, January and February Some few between April and July move west or south-west, and still fewer north or north-west.—The Hon. F. A. Rollo Russell described the results of observations which he had made on haze and transparency during 1897. He found that the greatest clearness occurred with winds from the westward, and the least clearness with winds from the eastward. The highest mean visibility was 24 miles with the west winds, and the lowest mean visibility was 10·6 miles with north-east winds.

PARIS.

Academy of Sciences, April 18.—M. Wolf in the chair.—Expression of tidal coefficients by means of a sum of periodic terms, by M. Hatt.—On the reduction of double integrals of algebraic functions, by M. Émile Picard.—On some derivatives of tetra-methyl-diamido-benzophenone, by M. E. Grimaux. The dinitro- and dibromo-derivatives are described, and colouring matters produced from them.—Sugar and fat from the point of view of their respective nutritive value, by M. A. Chauveau. In these cases the subjects under experiment were kept at rest; the results were similar to those obtained in the previous experiments, the sugar diet being always superior to the thermally corresponding fat diet.—The committees were nominated for awarding in 1898 the prizes bearing the names of Wilde, Vaillant, Desmazières, Montagne, La Fons-Melicocq, Thore, Savigny, Montyon (medicine and surgery), Bréant, and Godard.—On the ellipsoid of Jacobi, by M. P. S. Krüger.—On the motion of a heavy body of revolution, suspended from a point on its axis, by M. E. Jahnke.—On the potential functions of the theory of elasticity, by MM. Eugène and François Cosserat.—On the transport of luminous

variations by means of a wire conducting electricity, by M. Dussaud. An application of the selenium cell.—On the influence of self-induction in the explosion by the electric spark of mixtures of marsh gas with air, by MM. H. Couriot and J. Meunier.—Influence of temperature upon chemical reactions, by M. Albert Colson. An experimental study of the effect of temperature upon the velocity of absorption of hydrogen sulphide by orthophosphate and pyrophosphate of silver, zinc phosphate, and copper phosphate.—On the ammoniacal bromides of silver, by M. Jarry. By the action of liquid ammonia upon silver bromide the two compounds $2AgBr.3NH_3$ and $AgBr.3NH_3$ are formed, the dissociation pressures of which were measured.—On the phosphoric ethers, by M. J. Cavalier. Monomethyl- and monoallyl-phosphoric ethers were prepared and their behaviour towards indicators examined. The results were analogous to those given by the corresponding ethyl ether. A table is given showing the heats of neutralisation of the three ethers by various bases.—On the alkaline sulphantimonites, by M. Pouget. The sodium sulphantimonites are formed under conditions analogous to the potassium compounds; they differ from the latter, however, by the facility with which they undergo oxidation to sulphantimoniates.—General reaction of ethylenic hydrocarbons; corresponding mercuric combinations, by M. G. Denigès. By treatment with acid mercuric sulphate, all ethylenic compounds (except ethylene itself) give yellow compounds of the formula $(HgSO_4.HgO)_3R''$, where R'' represents the hydrocarbon. Compounds of propylene, butylene, and amylene are described.—Heat of formation of some quinones of high molecular weight, by M. Amand Valeur. The quinones used were: α-naphthoquinone, β-naphthoquinone, anthraquinone, phenanthrenequinone, and retenequinone; the results are compared with α- and β-naphthols, new data for which are given.—Heats of neutralisation of ethylphosphoric acid, by M. G. Belugou.—New synthesis of 3·3-di-methyl-1·5-pentanedioic acid, by M. F. E. Blaise.—Spectrum analysis of non-conducting substances by fused salts, by M. A. de Gramont. The finely-powdered mineral is fused with either lithium carbonate, boric acid, or potassium bisulphate, the first for preference, and the sparks passed through the molten mass.—On the functions of cerebral hypophysis, by M. E. de Cyon. The slightest pressure upon the hypophysis is immediately followed by a sudden variation in the blood pressure, and by a marked decrease in the number of heart beats per minute.—Effects upon man and mice of the inoculation of a pyogenous Tricophyte, by MM. Sabrazès and Brengues.—The parasites of cancer and of sarcoma. Coloration, structure, cycles of reproduction, and dimorphism, by M. F. G. Bosc.—Contribution to the study of direct cellular division; its anomalies and functional value, by M. Joannes Chatin.—On the Annelids collected by the expeditions of the *Travailleur* and *Talisman*, by M. Louis Roule.—On a cavity in the integument serving in the *Myrmicinæ* to spread out a secretion product in contact with air, by M. Charles Janet.—Variations, in four phases, of the pressure and of the two mean components of the wind on the meridian of the sun and its orthogonal, by M. A. Poincaré.—Influence of the movements of the moon on the oscillations of the atmosphere, by M. P. Garrigou-Lagrange.

DIARY OF SOCIETIES.

THURSDAY, APRIL 28.

ROYAL SOCIETY, at 4.30.—On the Meteorological Observatories of the Azores: H.S.H. the Prince of Monaco.—A Compensated Interference Dilatometer: A. E. Tutton.—Observations on the Action of Anæsthetics on Vegetable and Animal Protoplasm: Dr. Waller, F.R.S., and Prof. Farmer.—A Calorimeter for the Human Body: Dr. Marcet, F.R.S.—An Experimental Inquiry into the Heat given out by the Human Body: Dr. Marcet, F.R.S., and R. B. Floris.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, APRIL 29.

ROYAL INSTITUTION, at 9.—Magneto-Optic Rotation and its Explanation by a Gyrostatic Medium (with Experimental Illustrations): Prof. A. Gray, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Steam Laundry Machinery: Sidney Tebbutt.

MONDAY, MAY 2.

SOCIETY OF ARTS, at 8.—The Electric Locomotive: Prof. Carus Wilson.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Self-intensive Refrigeration of Gases, Liquid Air and Oxygen: Dr. W. Hampson.

VICTORIA INSTITUTE, at 4.30.—British Submerged River Valleys: Prof. Hull, F.R.S.

TUESDAY, MAY 3.

SOCIETY OF ARTS, at 8.—Senefelder and the Centenary of Lithography, 1798–1898: Joseph Pennell.

ZOOLOGICAL SOCIETY, at 8.30.

WEDNESDAY, MAY 4.

SOCIETY OF ARTS, at 8.—The Revival of Hand-loom Weaving: Miss Clive-Bayley.

GEOLOGICAL SOCIETY, at 8.—The Carboniferous Limestone of the Country around Llandudno: G. H. Morton.—On the Graptolite-Fauna of the Skiddaw Slates: Miss G. L. Elles.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, MAY 5.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—On some Spitsbergen Collembola: Sir John Lubbock, Bart., M.P., F.R.S.—On the Structure and Development of *Soranthera*: Miss Ethel Barton.—The Species, the Sex, and the Individual: J. T. Cunningham.

CHEMICAL SOCIETY, at 8.—The Reactions of the Carbohydrates with Hydrogen Peroxide: C. F. Cross, E. J. Bevan, and Claud Smith.—The Properties and Relationships of Dihydroxytartaric Acid, Part II.: H. J. H. Fenton.—The Affinity Constants of certain Hydroxy-acids: S. Skinner.—Molecular Weights in Solution of Permanganates, Perchlorates, and Periodates: J. Murray Crofts.

FRIDAY, MAY 6.

ROYAL INSTITUTION, at 9.—Living Crystals: Edward A. Minchin.

GEOLOGISTS' ASSOCIATION, at 8.—Notes on Skye: Horace B. Woodward, F.R.S.—Observations in Lapland: Aubrey Strahan.

SATURDAY, MAY 7.

GEOLOGISTS' ASSOCIATION.—Excursion to Hillmorton and Rugby. Director: Beeby Thompson.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

BOOKS.—Domestic Science Readers: V. T. Murché, Book vii. (Macmillan).—Flower Favourites: L. Deas (Allen).—A Century of Vaccination Dr. W. S. Tebb (Sonnenschein).—Maryland Geological Survey, Vol. I (Baltimore).—Iowa Geological Survey, Vol. vi. (Des Moines).—Magnetismo e Ipnotismo: Dr. G. Belfiore (Milano, Hoepli).—Museums Association, Report of Proceedings &c., at the Eighth Annual Meeting held in Oxford, July 6 to 9, 1897: edited by J. Paton (Dulau).—Handbook of Jamaica, 1898 (Stanford).

PAMPHLET.—Das Physikalisch-Chemische Institut der Universität Leipzig und die Feier seiner Eröffnung am 3 Januar 1898: Prof. Dr. W. Ostwald (Leipzig, Engelmann).

SERIALS.—Journal of Anatomy and Physiology, April (Griffin).—Journal of the Chemical Society, April (Gurney).—Quarterly Review, April (Murray).—Home University, April 15 (West).—American Journal of Mathematics, Vol. xx. No. 2 (Baltimore).—Journal of the Marine Biological Association of the United Kingdom, April (Dulau).—Himmel und Erde, April (Berlin, Paetel).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1898, No. 3 (Bruxelles).—Wide World Magazine, April (Newnes).

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